EXPLAINING

LANTERN PROJECTIONS IN GENERAL,

AND THE

SCIOPTICON APPARATUS IN PARTICULAR.

INCLUDING

MAGIC LANTERN ATTACHMENTS,

EXPERIMENTS, NOVELTIES, COLORED AND PHOTO-TRANSPARENCIES, MECHANICAL MOVEMENTS, ETC.

BY

L. J. MARCY, OPTICIAN,

No. 1340 CHESTNUT STREET, PHILADELPHIA.

SIXTH EDITION.

PREFACE.

VISIBLE illustrations are so highly esteemed among educationalists of the present day, that the announcement that a greatly improved form of Magic Lantern has made its appearance is very favorably received.

Between a desire for such an instrument and the lack of definite information concerning it, many very naturally manifest both their interest and their caution by searching letters of inquiry. The inventor has endeavored, in hasty epistles, to state all the possibilities and impossibilities of the Sciopticon, and of lights, lenses, lantern slides, and tanks—but he finds it increasingly difficult to give every correspondent, individually, a full and complete philosophical exposition. For such, therefore, as may desire a

a lens, in the camera obscura, in the eye, in the photographic camera, and on the screen; of the peculiarities of lenses, and the corrections required by lenses; of the peculiarities of the Sciopticon, and its construction and management; of dissolving views, phantasmagoria, and the ghost; of lantern slides in all their variety; of photographing slides by the wet-plate process, by the dry-plate process, by Marcy's Photographic Printing Apparatus, by the Sciopticon, and other processes; of how to paint slides, and of how to perform chemical experiments, &c.; to which is appended a catalogue, arranged to assist purchasers in making satisfactory selections.

Thus this Manual may take the place of private correspondence to a considerable extent, allowing in letters more space for business, and for an interchange of new ideas, with a view of making the Manual in subsequent editions more interesting, and the Sciopticon more useful.

It was at first my intention to give space to the sub-

without a corresponding addition to its usefulness.

PREFACE TO SEVENTH EDITION.

THE lime light, in an improved form, having been introduced into the Sciopticon, it has become expedient to append to the Sciopticon Manual, a description of the apparatus and directions for its use.

The demand for Lantern projections is steadily on the increase. A fine photograph (and what can be finer?) projected upon a large screen, before a thousand spectators, gives, it is safe to say, ten thousand times the satisfaction that one alone with his stereoscope receives from it. The appreciation is cumulative. "The more the merrier," is the philosophy of it.

The Sciopticon with its oil lamp, rather than with its lime light, continues to be the choice of the many, because its use is convenient and inexpensive. There are purposes and occasions however for which the lime light is a necessity. The *gas* therefore has now received its

Petroleum, as is well known, beats the whole animal kingdom, from the little busy bee to the great whale, in giving us good, cheap, and abundant light but it is not so well known that petroleum in the form of gasoline of 88 gravity is in effect a condensed hydro-carbon gas, and that for the lime light the hydro-carbureter has great advantages over hydro-carbon gas condensed in cylinders the charge being introduced without force, and resting in willing captivity to capillary attraction, which yields to a current of air or oxygen the hydrogen element of the lime light in the fittest condition to be brought to a focus on the lime by an independent branch of oxygen. In fact this process is but just introduced into the Sciopticon Manual A hint in this direction is found in a former edition, as follows: "My efforts to advantageously substitute hydro-carbon vapor in Burner No. 1 have not yet proved fully successful, though hope still survives." This hydro-carbureter, so skilfully made ready to my hand by others, fully answers my great expectations, and so I have undertaken its manufacture and sale for lantern purposes.

Hitherto the electric light has not been successfully used in the lantern. But I now have the pleasure of calling attention, in this seventh edition of the Manual, to Edgerton's Electric Arc-light Focusing Lamp, by which a continuous and steady light results from the Edgerton and Doriot patent feed, and from its being held to a fixed and indestructible iridium point.

	PAGE
Introduction,	xi

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

PHOTOGRAPHY.

CHAPTER VI.

COLORING SLIDES.

CHAPTER VII.

CHEMICAL EXPERIMENTS.

CHAPTER IX.

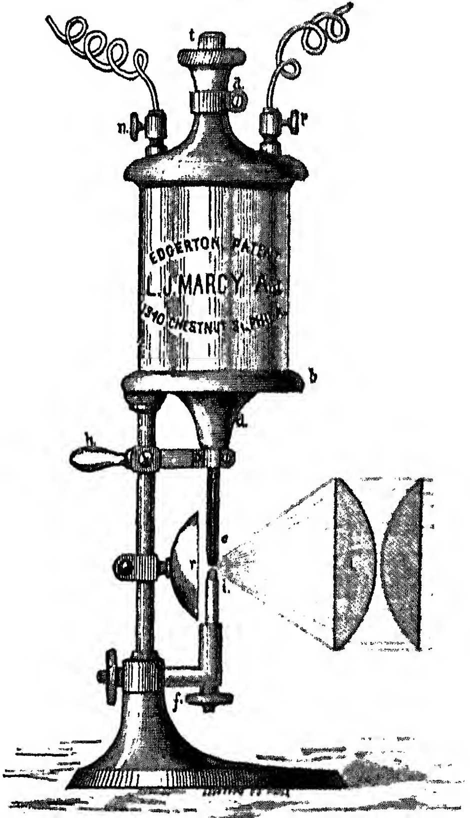
THE SCIOPTICON AND ITS USES.

CHAPTER X.

THE TEACHER HIS OWN ARTIST.

CHAPTER XI.

NOVELTIES.


t
a
n.
r
EDGERTON PATENT
L. J. MARCY
1340 CHESTNUT ST. PHILA.
b
d
h
e
r
i
f

INTRODUCTION.

THE SCIOPTICON (pronounced Si-op-ti-con), is by far the most convenient and easily managed of any form of Magic Lantern. Its ridge of wide, intensified double flame, lying lengthwise in the axis of the condensing lenses, gives it much greater efficiency than any other lamp-illuminated lantern.

All who have become acquainted with this new instrument, see in it the accomplishment of what has long been greatly desired by those who appreciate the value of visible illustrations as a means of imparting instruction and of affording rational amusement.

Confessedly, the medieval magicians with their *lanterne magique* effected little good by their incantations and ghostly spectres. But modern educators have higher aims and better means at hand. Their lenses

lections can be easily copied for lantern slides. And now the Sciopticon, with its own peculiar light for all ordinary occasions, and with the oxy-hydrogen light for occasions extraordinary, comes in to show up what is thus made ready.

In form and construction the Sciopticon is very unlike that relic of the middle ages, the old magic lantern. Those who are interested in the philosophy involved in it, in the peculiarities pertaining to it, in the practical management of it, in making and selecting slides for it, in performing scientific experiments with it, and in promoting the interest of education by it—will do well to inquire within.

SCIOPTICON MANUAL.

CHAPTER I.

THE CAMERA OBSCURA.

A picture formed by rays of light from the several parts of an object as seen at *A* (Fig. 1), is called an *image;* and the *chamber* in which it is formed, and from which all light is excluded, except what enters a small hole as at *S*, is called a *camera obscura.*

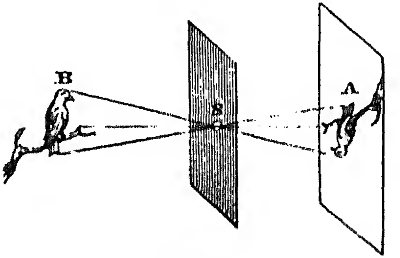


Fig. 1.

This dark chamber

each point will enter the hole at S, just in line to fall in reverse order upon the screen A, forming an inverted image.

The picture results from admitting just an assortment and excluding all the rest.

COLOR AND SHADING.

Light from each of the several parts of the object B illuminates with its peculiar color and relative intensity each corresponding part of the image, so that it is seen in natural light and shade, and in natural colors. The photographer can fix the relative shading, but he cannot, as yet, fix the colors.

MOTION.

If, for example, the bird moves to a higher perch, the pencils of light will fall to a lower place on the screen, and so any movement of the object which alters the direction of the pencils of light, will give a reverse movement to the image.

SIZE.

By inspecting the angle of extreme rays it will be seen that the image in this case is smaller than the object, because it is nearer the aperture; so in all cases, the relative size of the image depends on its relative distance from the aperture.

in the middle of which is the pupil (or aperture). As the retina is only about half an inch behind the optical centre, it follows that the images of distant objects upon it must be very minute.

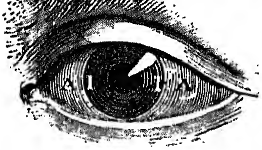


Fig. 2.

For example, the figure of a man 6 feet high, seen at a distance of 40 feet, produces an image upon the retina the height of which is about $\frac{1}{14}$th part of an inch. The face of such an image is included in a circle whose diameter is about $\frac{1}{12}$th of the height, and therefore occupies on the retina a circle whose diameter is about the $\frac{1}{170}$th part of an inch; nevertheless within this circle, the eyes, nose, and lineaments are distinctly seen. The diameter of the eye is about $\frac{1}{12}$th of that of the face, and therefore, though distinctly seen, does not occupy upon the retina a space exceeding $\frac{1}{4000000}$th of a square inch. How infinitely delicate must be the structure of the retina or canvas on which this exquisite miniature is delineated to receive and transmit details so minute with such marvellous precision!

SIZE IN THE PHOTOGRAPHIC CAMERA.

A man 6 feet high, standing for his picture 10 feet from a camera tube whose lenses require the screen of

A good portrait objective for the camera is also suitable for a lantern objective; for the lines of light and the angles are in both cases the same.

INFERENCE 2.

The light, if reflected from the three-inch picture, radiates so as to cover 100 times as much surface on the magnified image. Now, as a very small fraction of this reflected light is re-reflected to the eye of the observer, it seems a hopeless undertaking, to make the opaque lantern practically useful in showing the images of small paper photographs, on a large scale, with any ordinary flames, however well arranged.

INFERENCE 3.

With an intense light at a point behind the three-inch transparency, converged by a condenser, so as to enter the objective through all points of the picture, the magnified image is illuminated with incident rays concentrated, and its exhibition becomes a success.

INFERENCE 4.

Additional light outside this point (as some recommend), would not fall in line with the objective so as to improve the illumination; while the additional heat and diffused light would be very objectionable.

darkening a room and admitting light through, say an inch hole. A room with but one window, and that looking from the sun, and towards objects illuminated by sunlight, is to be preferred. A lens, if one is used, of long focal distance (nearly flat) gives more room for spectators before the screen. The images, if the lens has short focus, may be better seen on the back of a semi-transparent screen by transmitted light, as they are seen on the ground-glass in a photographic camera. Those moving pictures of busy life and wavy trees, of curling smoke and floating clouds, are peculiarly pleasing and beautiful, as well as suggestive of important principles in optics.

INDISTINCTNESS.

Fig. 1 fails of showing the divergence of each pencil of light to the size of the aperture as seen at *c* (Fig. 3);

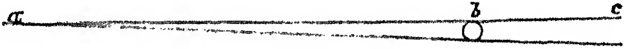


Fig. 3.

a property which renders the image indistinct, from the consequent overlapping of the blunt ends, so to speak, of innumerable pencils.

CONVEX LENS.

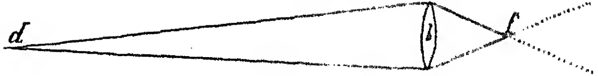


Fig. 4.

degree of convexity. For a lens to sharpen the image, the screen must be *adjusted* to the focal distance.

STOPS.

To get on the same plate something like distinct images of objects at various distances, a "stop" is used by the photographer, which, though it necessitates long exposure, secures "depth of focus." This expedient of having a small aperture is also resorted to for lessening the defects or aberrations of lenses, just as the aperture *b* (Fig. 3) is made small to lessen the greater defect of having no lens.

Stops are not used in the Sciopticon objective, because all portions of the picture-slide are in the same plane, and because sharpness produced by stops is always at the expense of light.

CHAPTER II.

THE CORRECTIONS REQUIRED BY LENSES.

successfully operate the Sciopticon, or even excel in photography, without a critical knowledge of lenses; but a very short, connected showing of their properties, with diagrams, will doubtless prove acceptable to many who use the Sciopticon, or who are interested in photography.

THE FORM OF LENSES.

The convex, or converging lenses. 1, 2, and 3 (Fig. 5), called biconvex, plano-convex, and meniscus, are thicker

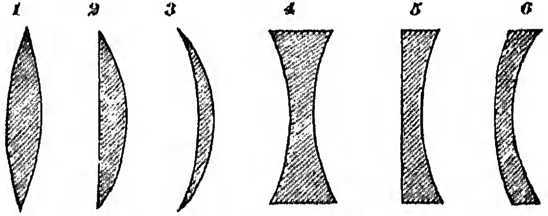


Fig. 5.

in the centre than on the margin. The concave, or dispersing lenses, 4, 5, and 6, called biconcave, plano-concave, and concavo-convex, are thinner in the centre than on the margin. A line through the centre of these lenses, from side to side, would show the axis of each lens.

PENCILS OF RAYS AND THEIR ILLUSTRATIONS.

no one is switched from the track for another, and there are no collisions. An explanation of one answers for countless millions.

SPHERICAL ABERRATION.

It is seen (Fig. 6) that the marginal rays $d\ d$ must be more refracted, or bent, than the more central rays $f\ f$,

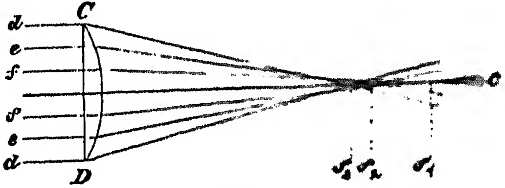


Fig. 6.

in order to meet the axial rays at f_1, and so it is seen that the margin of the lens $C\ D$ has a greater refracting angle than the more central portions. But the trouble is, the refracting at the margin is overdone, so that the rays $d\ d$ meet the axial ray at f_3 instead of at f_1. Hence if a ground-glass has been placed at f_1, the marginal rays which have intersected the axis at f_3 will form a circle of dispersion about f_1. The diameter of this circle is called the lateral aberration, and the distance between f_3 and f_1 is called the longitudinal aberration. As a con-

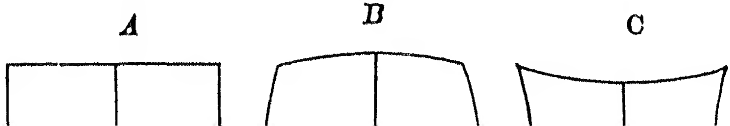
sequence of this want of coincidence between the foci of the central and marginal rays the picture on the screen, or ground-glass, will appear blurred and ill defined.

We can conceive of a lens with a gradually lessening degree of convexity towards the margin, causing the foci to coincide, but lenses cannot well be ground in this form. The crystalline lens in the eye is supposed to cause the foci to coincide by an increase of density towards its centre, but such an arrangement of matter would be impracticable in art. Much is gained by reversing the lens, for spherical aberration is four times as great when the parallel rays enter its plane surface, as when they enter its convex surface.

Much is gained by a combination of lenses so that the refracting angle may be less in each. Were the marginal rays *d d* cut off by a stop, the aberration would be less, as we can see by tracing them in the diagram, but the illumination would also be less by so much.

DISTORTION.

When we focus with a single lens with a front stop



Of the simple form of lenses, the meniscus, with its concave side to the object, shows it the least. But it is best overcome by a combination of lenses with central stops.

CURVED FIELD.

This error is not caused by spherical aberration, for it occurs with all perfectly aplanatic lenses, but by the curve of the image, as is shown by the arrow, Fig. 8.

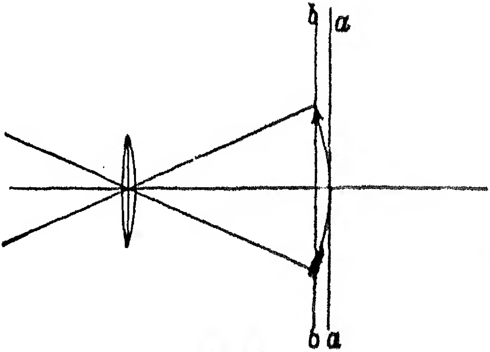


Fig. 8.

When the ground-glass is placed at a a, only the central part will appear sharp; when at b b, only the points of

primary colors, violet, indigo, blue, green, yellow, orange, red.

As a lens is analogous to a system of prisms, and as violet is more refrangible than red, the violet rays v v (Fig. 9) will intersect the axis closer to the lens than the red rays r r. This error is corrected by combining a concave lens of flint-glass with a convex lens of crown-glass, so as to neutralize their contrary dispersions.

The concave flint-glass lens f (Fig. 12), which has great dispersive power in proportion to its curves, diverges the violet more than the red, while the convex crown-glass lens converges the violet more than the red, so we have in both combined an achromatic convex lens. As the chemical rays are in the violet end of the spectrum, the photographer may succeed with an im-

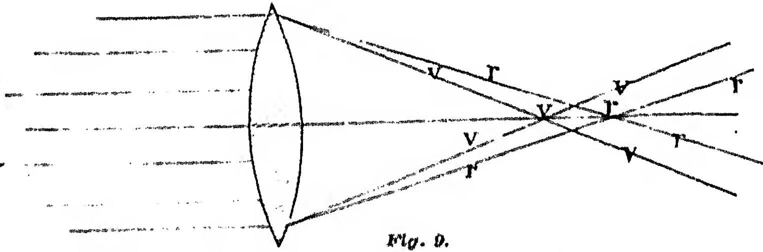


Fig. 9.

perfectly corrected lens by having the sensitive plate a little nearer the lens than the focus of luminous rays on the ground-glass would indicate. Lenses without chro-

from the centre towards the margin. The diameter of the pencil $g\ g$ passing through the lens parallel to its axis, is of the same size as the opening of the stop B, and exceeds the diameter of the oblique bundle of rays. Besides, the oblique rays lose considerable light by reflection, which may in part be re-reflected upon the image,

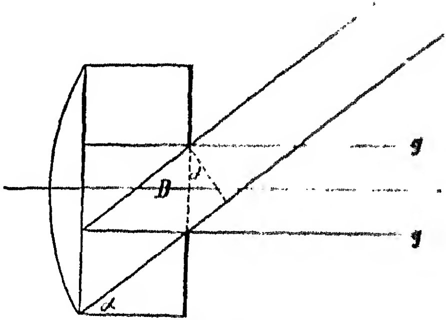


Fig. 10.

detracting from its distinctness. With a short exposure in the camera, this unequal illumination causes an under exposure at the margin. In the Sciopticon it is even exaggerated by the reflector, but we generally wish the objects occupying the central portion of the "*field of view*" to stand out more clearly in the illuminated disk.

CORRECTIONS IN THE EYE.

Spherical aberration and distortion in

there is no need of adjusting the focus to a flat field.

The eye is readily, for the most part unconsciously, adjusted, so that an object upon which we fix our attention is at once in the centre of the field of view, and is focused according to its distance.

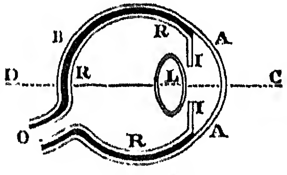
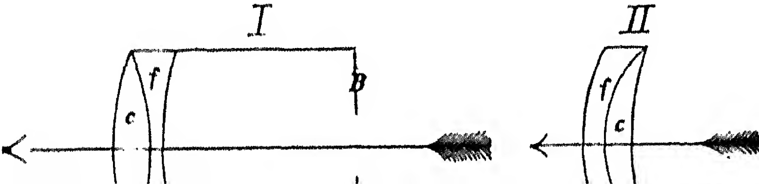


Fig. 11.

These five troublesome properties enumerated in this chapter, are thus, in the eye, harmoniously reconciled. In art we lack the peculiar crystalline lens, and the concavity of field. Making amends for this lack interferes with other corrections. Efforts of various makers to effect the best compromise for particular kinds of work has given rise to lenses, in variety too numerous here to particularize.

THE LANDSCAPE LENS.

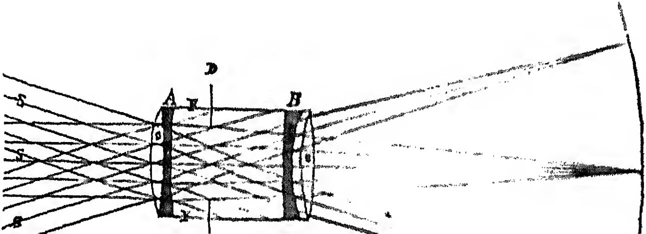
This simple achromatic lens (Fig. 12) is the oldest photographic lens in existence. It is composed of the



Among the modified forms, the Dallmeyer Landscape Lens, which consists of three lenses cemented together, a central one of flint-glass and two outer ones of different kinds of crown-glass, gives better results. The stop *B B* is generally one-fifth of the focal length distant from the lens, and consequently cuts off much of the light. In the earlier days of photography a person had to sit in front of such a lens, in a strong light, for several minutes. That in this way no artistically perfect pictures could be made is self-evident, and so it became necessary for portrait photographers to have a lens that would work satisfactorily with a larger opening.

THE PORTRAIT OBJECTIVE.

This invention is no accident, but the result of a thorough theoretical calculation. It is a double objective with two unequal lenses, with or without central stops between.



marginal rays entering the lens A do not reach the lens B, because of the length of the tube $F F$, which effects about the same result as the slight stop $D D$.

The curvature of the field is somewhat exaggerated in the diagram, to remind us that an aplanatic lens cannot give a perfectly flat field without a stop. In this general form all portrait lenses mostly coincide, differing in regard to the focal length of the separate objectives A and B, the distance and size of the same, the position of the stops, &c.

Considering Fig. 13 as representing a portrait objective, the pencils $S S S$ proceed from an object comparatively large and distant, forming a small image in the camera. Considering the diagram as representing a lantern objective, the order is reversed. A small transparency is in place of the curved line, which in its turn becomes the focus of incident rays, projecting upon a screen a comparatively large and distant image where the pencils $S S S$, if extended, meet in a focus of refraction. B is called the back lens in either case, as it is back next to the instrument to which the tube is attached.

THE PORTRAIT OBJECTIVE.—This objective (Fig. 13 or 15) is made for the camera, and is known mostly in its relations to photography. An objective, however, that with large opening, will give proper direction to rays from a large object to a small image in the camera, will answer equally well in giving direction to rays from the small picture in the Sciopticon back to life size on a screen; both object and image being in the conjugate foci in either case.

THE PLAIN LANTERN OBJECTIVE.—This objective, like the achromatic portrait objective (Fig. 13 or 15), has the advantage of a front and a back lens, *A B* (Fig. 14), so far apart that the tube serves as a stop for marginal rays with comparatively small loss of light. The front lens *A* is a meniscus of crown-glass, whose tube slides into a larger tube which holds the plano convex crown-glass lens *B*. Arranged as in the diagram, the effect is scarcely inferior, so far as common observation goes, to that of the most expensive combinations. With the front tube reversed, so as to bring *A* near to *B*, the image is larger but less distinct. With only one lens the image is smaller. These different arrangements give the three powers commonly attributed to lenses mounted in this form.

NO LOSS OF LIGHT FROM USING AN OBJECTIVE OF

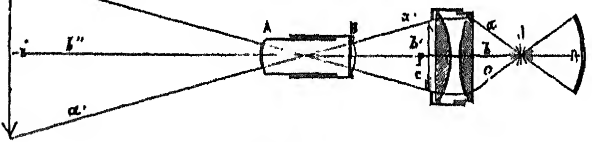


Fig. 14.

to bear on the image. But the light in fact proceeds from *l*, and what passes through the condenser and picture becomes a cone of light, with its apex in the objective.

This cone of light must be regulated by the position or power of the condenser so as to fall within the compass of the objective. Except for some reflections from the surfaces of the glasses, the light would not illuminate the room at all in its passage, and there would not be even the small need there is of the hood *i* (Fig. 15).

ADVANTAGES OF A CONCENTRATED LIGHT.

Could the light proceed from a mathematical point behind a faultless condenser, the pencils *a′ b′ c′* (Fig. 14) would be without marginal rays, and there would be nothing for the objective to do, for its office is to bring the marginal rays of each pencil to coincide with the axial ray. Were we to adjust the aperture of our window shutter (Fig. 1), to the apex of the cone, there would be no rays for the shutter to cut off. The image

We conclude, therefore, that the more concentrated the light, the nearer in each pencil will the marginal rays coincide with the axial ray, and the less will the imperfections of lenses become manifest.

THE CONDENSER.

The condenser is formed of combined lenses, because the refracting angles would be too great in a single lens of sufficient diameter and short focal distance.

The simplest arrangement is where two plano-convex lenses are combined, with their curved surfaces inwards, as in Fig. 14, or at *p q* in Fig. 15. The shorter the focus of the condenser, the shorter, with a given objective, must be its distance from the light; it will collect more light, but it will be in more danger of breakage from the heat. In the Sciopticon the space between the lens *q* (Fig. 15) and the front of the flame is only about two and a half inches, but the glass *G*, and the air between it and *q* rising up and out at *A*, makes it perfectly secure. The condensing lenses in the Sciopticon are usually each 4 inches in diameter; but a 4½ inch front condensing lens, *p*, is used to advantage for slides larger than the standard size, and to show fully the corners of some of the ordinary square transparencies.

THE REFLECTOR.

With proper adjustments, the light *l*, with that from the reflector, is focused at the objective tube, of a comparative size proportionate to its relative distance from the condenser; and the picture *p* is focused upon the screen at *i* of a comparative size proportionate to its relative distance from the objective. As represented in Fig. 14, the smallest diameter of the cone of light in the objective *A B* would be twice that of the point of light *l*, and the height of the image *i* would be twice that of the picture *p*.

To project a picture to a great distance without too much enlargement, the objective must be of low power and carried forward; and the light should be from a point (as in the calcium light) to avoid loss, and should be carefully adjusted to secure even illumination.

The longitudinal ridge of light *E* (Fig. 15), with a medium objective gives uniformly good results without perplexing experimental adjustments.

VARIOUS MODES OF LANTERN ILLUMINATION.

The Hydro-Oxy-Calcium light, or lime made incandescent by a jet of hydrogen and oxygen in flame upon it, is the most brilliant available light. Its concentrated form adds greatly to its value for the lantern. The Oxy-

lantern exhibition is too liable, even with well regulated clockwork, to leave the lookers-on in sudden darkness.

The Electric light is intense and concentrated, but it requires too much apparatus to be available.

The above so-called chemical lights, are, if *well* managed, much brighter than flame, even at its best. The Sciopticon has a double flame, which is not only very bright, but gives much more distinctness to the image, by its standing edgewise to the condenser instead of broadside, as a single flame must, to prevent its casting a dark shadow on the disk. No lantern of any sort can compare with the Sciopticon in point of convenience. We may conclude that the Hydro Oxy-Calcium light is best for exhibitions on a large scale, and as for the rest, the Sciopticon is desirable as combining efficiency and great convenience.

THE SIZE PROPER FOR THE ILLUMINATED DISK.

The image enlarges in area, and diminishes proportionately in brightness, as the distance of the lantern from the screen increases. A disk of six or seven feet is about right for figures, statuary, &c., to give brightness and not an unnatural size; while landscapes, &c., appear better on a disk of eight or ten feet, or more.

tion. What is left of the frame and cylinder, the lamp, chimney, reflector, &c., are shown in perspective. The parts are as follows:

a b—Front combination of the objective cemented together.

c d—Back combination separated by a ring. If the cells holding these combinations are unscrewed and the lenses removed, they must be returned in the same order and position as seen in the diagram. There is no need of removing them. Even the outer surfaces of *a* and *d* will seldom need dusting if kept in a clean place with the caps closed. They should not be fingered, and the brush or fabric used for dusting them should be clean and soft.

e—Milled head for adjusting the focus.

f f—Flange attached to the projecting wooden ring *g g*.

The tube here represented is a quarter-size portrait camera tube of 4½ inches back focus, requiring an aperture in *g h* of 2⅜ inches in diameter. If a larger tube is used, the aperture in *g h* has to be enlarged. If the back focus is more than 5 inches, the extension front *h k* must be drawn out more or less from the main body, as is shown in the diagram. If the focus is shorter than 3½ inches, the ring *g g* is removed, letting the flange *f* back to *h*.

h h h′—Wooden frame of the extension front; *h′* sliding in a groove within the body-frame *l l*.

i—Top of the hood covering light dispersed by reflection. The near side is cut away to show the screen *k*; the edge of the remaining side is seen beyond *k*.

k Is now modified into a horizontal lid, which shuts up over the lens *d*, darkening the picture on the screen like a falling curtain.

l l—Portion of the wooden frame, the rest being mostly cut away to show the lamp, and how the extension front slides in its groove.

while the rear ends may be spread apart till the disks on the screen coincide.

o o′—Stage and spring for wooden-mounted pictures. The operator standing behind, slides a picture horizontally in at *o*, letting it bear against the condenser mounting, and letting it project equally

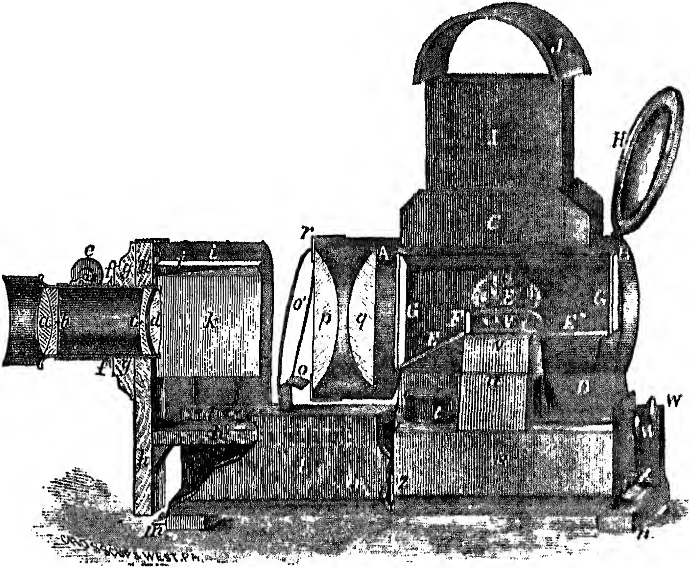


Fig. 15.

both sides of the cylinder. The picture is drawn out with the left hand, while with the right hand another is made to follow in its place, so as not to show the white disk on the screen.

o is lifted out of its place.

s—Lamp cup for kerosene oil. It holds three gills, or enough to last about 4 hours. When it has to be moved about much, it is better not to fill it more than two-thirds full, for if any oil gets outside, it gives off its offensive smell; while if there is no oil outside there is no smell from it in the least. When packed for transportation, the oil should be thoroughly drained off.

t—Nozzle to admit the oil. It is large, so that if a wick is carelessly turned down into the cup, it can be fished out with a bent wire.

u—Side of one of the two tubes, showing how the conduction of heat downwards is counteracted by breaking the connection in the metal. It is made of tin, for the reason that it is a slower conductor than brass.

v v—Tops of the two tubes. They carry No. 3 wicks, which are an inch and a half wide. The lamp being taken out, the wicks are pushed down the tubes till they are caught by the ratchet-wheels and drawn down. Should a loose thread of the wick get clogged in the wheels it must be drawn out and cut off. The ratchet-wheels could be made to bear tighter on the wicks by pounding gently along the bottom of the tubes, but such a necessity is not likely to happen.

w w—Buttons for adjusting the wicks; both are turned *inward* to raise the wicks, and *outward* to draw them down.

x—Spring for holding the lamp.

z—Stop, preventing the lamp from sliding in too far.

A B—Portions of the cylinder not cut away, seen beyond the condenser and flame-chamber.

C—Portion of the cylinder turned up, to give free ventilation all about the flame-chamber.

F—Narrow strip of glass, quarter of an inch wide, held in a socket before the flame, to give upward direction to heated air. It will not crack from heat because it is so narrow, and without obstructing light it takes from the glass *G* its liability to crack.

G—Front of flame-chamber glass. It is now held in a tin frame by a wire ring, so that should it crack, it is still kept in place without harming the effect on the screen.

G′—Back flame-chamber glass. The lamp is lighted by removing this glass, and reaching the wicks with a lighted match. *G G′* must be in place to secure the draft. *F*, especially since the introduction of the tin frame for *G*, is scarcely necessary.

H—Reflector, used also to close the rear of the cylinder. The centre of concavity is at *E′*, so that reflected rays are thus made to coincide with incident rays from *E′* to the condenser.

I—Chimney, giving large outlet to heated air.

J—Chimney cap, for darkening the outlet. It may be raised to increase the draft, when the lamp gets to burning freely enough to bear it.

PACKING.

No instrument is forwarded without being first proved by careful trial. The oil is then poured off, and the lamp burned awhile afterwards, to prevent any further drainage should it be shipped wrong side up. Let this precaution be taken by all who pack the instrument for transportation, that there may be none of the offensive smell of oil when the instrument is unpacked and used.

The wicks are left in the tubes, ready for use. Four

condensing lenses.

The cap J is removed and placed behind the chimney. The whole is snugly packed in a box with stuffing, and the cover fastened on with screws. These particulars may be advantageously referred to in case of repacking by the purchaser or borrower.

RULES FOR OPERATING THE SCIOPTICON.

In unpacking a new instrument the parts must be separated, to remove the packing papers.

Dust them if necessary.

For the lenses and reflector use a duster that is soft and clean.

Warm and dry the condensing lenses if inclined to fog.

Adjust F, G, G', J, and the lenses, as seen in Fig. 15.

Shut the extension front back to its place.

Fill the lamp about two-thirds full with standard kerosene oil. The fire test should be 110° at least; that of Pratt's astral oil is 145°.

Avoid carelessly tilting the lamp when it is very full, and so avoid the smell of oil evaporating from the outside surface.

Turn down the wicks, so they will not rub against the deflecting plate while withdrawing or inserting the lamp.

It is convenient to stand the instrument so as to be

be left dimly burning in the distance, or out of range of the screen.

Light the lamp in the instrument, as it stands in the diagram, by removing the back glass, G', turning up the wicks by a turn inward of the buttons w w, and reaching the wicks V V through E with a lighted match. To avoid smoke, turn the wicks almost down again till the glass is replaced.

Turn up the flames evenly about half an inch at first; they will rise a little after the wicks are warm, when they may need looking to again, after which they will stand steady without requiring further attention.

Put out the light by drawing the wicks down with a turn of the buttons outward, and then blowing under the reflector.

The wicks may be trimmed when the lamp is taken out to be filled; cut them level; it may be done more evenly by only removing the black part.

If kept in a dry place the reflector will keep its polish for a long time; it is protected by a film which should not be rubbed.

While exhibiting, the operator should stand behind the instrument, having the slides arranged at his right, in the proper order and inverted position required for exhibition. If the instrument is in front of the screen, the wire ring fastening the double glass into the wooden mounts should be towards the condenser, in order to

Take the slides out with the left hand as others are pushed into place, so as to leave none of the white disk visible, and put them in their box as before. A slide standing endwise between those which have been used and those which have not, will keep them apart.

As photographers are giving increasing attention to preparing slides, there is an increasing proportion in the market of the size of half a stereoscopic view, or 3¼ inches square, bound with narrow binding. For these a wooden stage 9 inches long is attached to $o\ o'$, so that, without crowding a picture out at the end, its successor may be pushed into its place, by the finger following to where the cylinder and stage intersect; with the left hand at the button attached to the back stop we may: 1. Close stop. 2. Slide in the picture. 3. Uncover—so that in the time of counting three we have changed the scene without any visible movement. This, well managed, is better than dissolving views poorly managed.

Tanks for insects, fish, chemical experiments, &c., &c., slide into the stage as easily as pictures. The stage being open at the top, with no bulky lantern case to obstruct it, is peculiarly suited to all such operations.

A slender wire in the direction $r\ o'$, answers the purpose of a long rod pointing upward on the screen to explain the representations.

The simplicity and completeness of the Sciopticon are more evident in practice than may seem while consider-

RECAPITULATION.

The front, $h\ h\ h'$, with its attachments, draws apart from the body of the instrument.

The stage $o\ o'$ lifts out.

The condenser, $p\ q$, is drawn out by laying hold of the ring r.

The cells holding p and q draw apart.

The front flame-chamber glass G is held in place by the spring A, which can be reached through the opening over A.

With $h\ o\ p\ q\ G$ removed, the narrow glass F (found packed with the extra wicks) is reached to position, and needs no further attention.

The portion of chimney attached to the cap J, telescopes into I.

The lamp S slides out horizontally, by raising the spring X.

With packing removed, glasses clean, lamp filled two-thirds full of standard kerosene oil, and all parts in place as seen in the cut, remove the back glass G', and reach the wicks $v\ v$ with a lighted match. Replace G', and let the flames stand about one inch high.

See, specially, that an oil so inflammable as to light at the safety slit u is not used—that no oil is left outside

public conveyance.

Standing behind the instrument, placed about breast high—as upon its box on a stand or table—close down the reflector *H*, pass in the slides at *o o′* with the right hand, taking them out with the left as other slides take their places. Focus the picture by the milled head *e*, upon the screen, which may be distant sixteen feet, more or less, as it is desired to have the scenes on a larger or smaller scale.

k (unlike the cut) is horizontal, and turns up to give the appearance of a falling curtain on the screen.

THE SCREEN.

There can be nothing better for the projected pictures than the white-finished, whitewashed, or white-papered walls of many a lecture-room or dwelling. An appropriate space specially set apart and papered with white wall paper, having an outline, say of a wide recess or niche for statuary, is an inexpensive and not inelegant fixture, on which to display before the assembled household, without waste of room or trouble in arranging, the richest treasures of all the art galleries in Christendom. The time is coming, when for purposes of demonstration and illustration in the lecture-room, this *whiteboard* will rival the *blackboard*.

The best material in the market for a movable screen of good size, seems to be bleached sheeting of close

the instrument is invariably to be placed in front, to cover the surface with whiting or paper, keeping it smooth by mounting it on a roller. When illuminated from behind, the screen should be wet, to tighten its texture and to make it translucent, and consequently luminous on the side towards the spectators. It can be wet and then stretched upon a frame, or first mounted and then sprinkled to saturation. For home use, a sheet may be stretched across the frame upon which the folding doors of most modern houses are hung, the doors being thrown open at the commencement of the exhibition. A waxed screen is often recommended, but it is little used on account of the difficulty of keeping it smooth and clean. An unmounted screen can be quickly put up in any room by procuring two strips of wood about two inches square, and long enough to reach from the floor to the ceiling; a side of the screen is tacked to each one of these strips, which are then stretched apart, and wedged up tightly between the floor and the ceiling.

To widen the screen to more than nine feet, join the added width to each side, rather than bring a seam into the centre of the views.

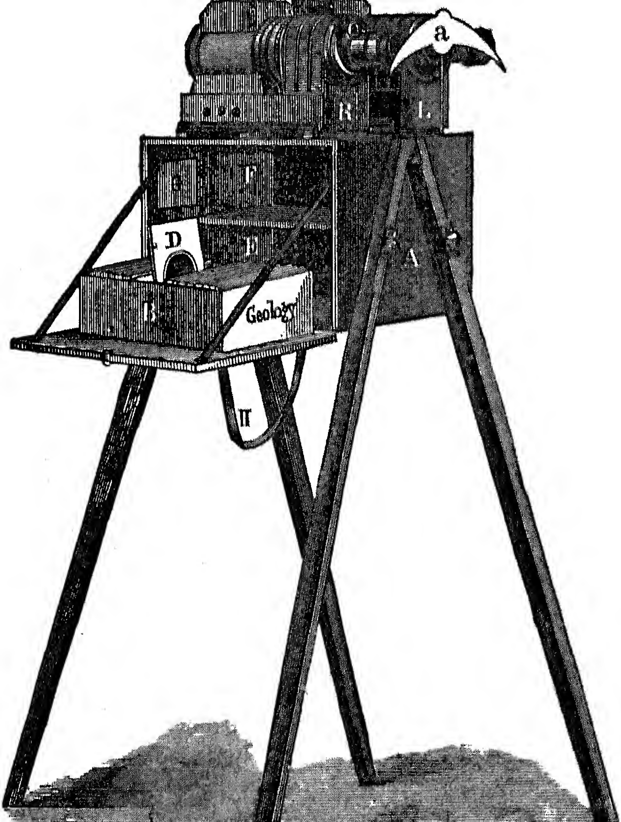
A fine picture from within, upon oiled muslin, stretched upon a frame, made to fit a show window, is always greatly admired by all the passers-by. Such a framed

apparatus, and so can better be described with it, but it is not necessarily a part of it.

It consists of a well-made walnut box, mounted on two pairs of adjustable legs, attached by fixed thumb-screws and nuts. The back legs are an inch or so shorter than those attached to the front at *A*, to elevate the range of the lanterns. The back of the stand may be known by the match-lighter *G*, and by its being necessary for the operator from behind to have the opening and the box of slides *B* at his right hand. The slide *D* stands on end, to separate the used from the unused slides.

When the apparatus is taken down, the legs swing together on their hinges, and are tied in a bundle; the open side of the box becomes the top; the instruments occupy the stalls *E* and *F*; the dissolver is drawn apart and placed alongside; the caps are removed from the chimney, and placed in the rear; the box of slides occupies the space in front; the swing shelf *C* becomes the lid and is locked down; the strap *S* and its mate, now hidden under the instruments, meet over the top for one carrier, or serve like the ears of a basket, for two.

But as a stand, as seen in the diagram, the front of the box becomes the baseboard, and like any other 13 by 17 inch board, affords suitable standing-room for the apparatus; it is more likely to keep it level than a sep-


a
R
L
D
Geology
II
A

The construction of the dissolver is shown in Fig. 17, in its three parts. The crescent-shaped dissolver *a* is mounted on the arm *b*, as seen in Fig. 16, so as to cover alternately the tubes on *R* and *L*, as it swings from side to side. The horizontal part of *b* slips into *c* till the length of the united axle just allows the dissolver to swing clear of the tubes, and the whole is held in place by a socket-spring at each end of the baseboard.

The dissolver is operated by the handles at *c*, which are adjusted at the proper angle to limit the lateral movement of *a* to the distance between the tubes.

Light the lamps in their place by reaching the wicks with a lighted match, and attend to them at first to see that they burn steadily and evenly. Focus a picture in *R*, for example, while *L* is covered by the dissolver, and

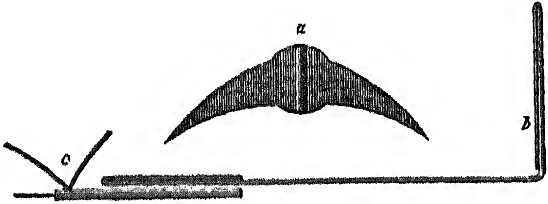


Fig. 17.

in *L* while *R* is covered; this reduces the disks to equal size on the screen. With the slides removed, and the dissolver in the position as shown in Fig. 16, spread the

moving of the dissolver will very mysteriously dissolve one view into another.

This effect is commonly produced with slides not specially arranged for the purpose, but it is desirable that they should be of similar size and shape, and that they should be put in evenly, so as to cover the same space on the screen.

Many slides are, however, selected and executed with special reference to their producing charming effects in dissolving.

They are mostly arranged in pairs, as some view in summer and the same in winter, by day and by night, interior and exterior, in sunshine and in storm, or humanity in opposite moods. Sometimes the series are more extended, as the Seasons, the Voyage of Life, &c., and sometimes they are in connection with chromatropes to represent volcanic action, conflagrations, fireworks, turning mills, &c. Suppose, for example, Saint Peter's, at Rome, is thrown upon the screen from *R*, and a night view of the same is placed in *L*; then as the dissolver is changed, Saint Peter's with its surroundings continues on the screen, but an appearance of night comes over it; the windows glitter with a thousand lights, and the moon makes its appearance in the heavens. Now, suppose a chromatrope, suited to the purpose, is placed in *R*, then as the change proceeds fire-

the farm-house scene again appears in the morning light, covered with the newly fallen snow of the winter's night.

To bring out statuary on a blue ground, a slide of blue glass, and usually one of red glass also is used. Change any scene, first into a red disk, then the red into blue, and then let a piece of statuary slowly come out into the blue ground, while the blue becomes darker and darker, till it ends in a blackness which seems to add vigor to the representation.

A beautiful effect is produced by a wheel chromatrope, used continuously in one of the lanterns, while a series is shown in the other, turning it inward and outward alternately, as the dissolving proceeds. It thus seems to suck up the vanishing scene as in a maelstrom, and to bring out its successor with scintillations of colored lights.

A pleasing effect is produced by showing a series of views in one lantern, and a veranda, or some appropriate design with opaque centre, with the other. If in adopting this suggestion, the veranda be focused for the edges of the field, and the view focused for the centre, a flat field is obtained over the entire disk. In this case, and in all cases when light from both lanterns is to appear, the dissolver is slipped up an inch higher, and kept in position as in Fig. 16.

easily effected in the apparatus represented. A ... cate picture placed in *R* and *L* in reverse ord... dissolver being changed back and forth with a s... movement, will show an "about face" as of a ... bowing to the company, a lion uneasy in his cage...

Lightnings may thus be made to flash upon sc... especially when the view is darkened somewh... turning down its light a little, giving the appeara... a rising tempest.

Discretion and good taste should be observed ... ranging the slides for an exhibition, so as not t... beauty with caricature, or sacred scenes with w... ridiculous; yet it is well to avoid monotony, for "v... is the spice of life."

Dissolving views, it must be confessed, are ... treated in a somewhat florid style by opticians... may be safe to make some abatement in anticipati... effects, especially of high-priced mechanical slid... when they chance to fall below the "Royal Polyt... Institute in London," there should be a feeling ... appointment.

In the Sciopticon enterprise, it has been kept st... in mind, to produce beautiful and useful results ... simplest means; and the desire is felt, not to m... large sales as possible, but to have every pur... realize his highest expectations.

with his right hand; the image of course will be very small; he must then walk slowly backwards, at the same time adjusting the focus. As the image increases in size, it will appear to the spectators to be coming towards them; and then again let him walk up towards the screen, thus diminishing the image, and it will appear to them as if receding. The screen not being seen, the image appears to be suspended in the air, and the deception is complete, even to those accustomed to the exhibition. The focusing is most evenly and easily effected by prying the extension front out and in with the thumb and fingers of the right hand.

Slides producing the best phantasmagorial effect are those containing but one or two figures with a black background. In ancient times, the images from the phantasmagoria were thrown on the smoke arising from a chafing dish in which odors and drugs were burning, and by means of which many surprising and apparently supernatural effects were produced. As a relief from so closely following practical details, let us advert to the probable use made by ancient magicians, necromancers, and sorcerers, of these optical contrivances for producing supernatural illusions. In this we cannot do better than to quote from that eminent authority on optical science, Sir David Brewster:

"In the imperfect accounts which have reached us of these rep-

"The character of these exhibitions in the ancient temple is so admirably depicted in the following passage of Damascius, quoted by M. Salverte, that we recognize all the optical effects which have been already described. 'In a manifestation,' says he, 'which ought not to be revealed, ... there appeared on the wall of the temple a mass of light, which at first seemed to be very remote; it transformed itself in coming nearer, into a face evidently divine and supernatural, of a severe aspect, but mixed with gentleness, and extremely beautiful. According to the institutions of a mysterious religion the Alexandrians honored it as Osiris and Adonis.'

"These and other allusions to the operations of the ancient magic, though sufficiently indicative of the methods which were employed, are too meagre to convey any idea of the splendid and imposing exhibitions which must have been displayed. A national system of deception, intended as an instrument of government, must have brought into requisition not merely the scientific skill of the age, but a variety of subsidiary contrivances, calculated to astonish the beholder, to confound his judgment, to dazzle his senses, and to give a predominant influence to the peculiar imposture which it was thought desirable to establish. The grandeur of the means may be inferred from their efficacy, and from the extent of their influence.

"This defect, however, is to a certain degree supplied by an account of a modern necromancy, which has been left us by the celebrated Benvenuto Cellini, and in which he himself performed an active part.

"'It happened,' says he, 'through a variety of odd accidents, that I made acquaintance with a Sicilian priest, who was a man of genius, and well versed in the Latin and Greek authors. Happening one day to have some conversation with him when the subject

one evening prepared to satisfy me, and desired me to look out for a companion or two. I invited one Vincenzio Romoli, who was my intimate acquaintance; he brought with him a native of Pistoia, who cultivated the black art himself. We repaired to the Collosseo, and the priest, according to the custom of necromancers, began to draw circles upon the ground, with the most impressive ceremonies imaginable; he likewise brought hither assafœtida, several precious perfumes, and fire, with some compositions also, which diffused noisome odors. As soon as he was in readiness, he made an opening to the circle, and having taken us by the hand, ordered the other necromancer, his partner, to throw the perfumes into the fire at a proper time, intrusting the care of the fire and perfumes to the rest, and thus he began his incantations. This ceremony lasted above an hour and a half, when there appeared several legions of devils, insomuch that the amphitheatre was quite filled with them. I was busy about the perfumes, when the priest, perceiving there was a considerable number of infernal spirits, turned to me and said, "Benvenuto, ask them something." I answered, "Let them bring me into the company of my Sicilian mistress, Angelica." That night he obtained no answer of any sort; but I had received great satisfaction in having my curiosity so far indulged. The necromancer told me it was requisite we should go a second time, assuring me that I should be satisfied in whatever I asked; but that I must bring with me a pure immaculate boy.

"'I took with me a youth who was in my service, of about twelve years of age, together with the same Vincenzio Romoli, who had been my companion the first time, and one Agnolino Gaddi, an intimate acquaintance, whom I likewise prevailed on to assist at the ceremony. When we came to the place appointed, the priest having made his preparations as before, with the same and even more striking ceremonies, placed us within the circle, which he had like-

by their names a multitude of demons who were the leaders of the several legions, and questioned them, by the power of the eternal uncreated God who lives forever, in the Hebrew language, as likewise in Latin and Greek; insomuch that the amphitheatre was almost in an instant filled with demons more numerous than at the former conjuration. Vincenzio Romoli was busied in making a fire, with the assistance of Agnolino, and burning a great quantity of precious perfumes. I, by the directions of the necromancer, again desired to be in the company of my Angelica. The former thereupon turning to me, said: "Know, they have declared, that in the space of a month you shall be in her company."

"'He then requested me to stand resolutely by him, because the legions were now above a thousand more in number than he had designed; and besides, these were the most dangerous; so that, after they had answered my question, it behooved him to be civil to them and dismiss them quietly. At the same time the boy under the pintaculo was in a terrible fright, saying that there were in that place a million of fierce men, who threatened to destroy us; and that, moreover, four armed giants of enormous stature were endeavoring to break into the circle. During this time, whilst the necromancer, trembling with fear, endeavored by mild and gentle methods to dismiss them in the best way he could, Vincenzio Romoli, who quivered like an aspen leaf, took care of the perfumes. Though I was as much terrified as any of them, I did my utmost to conceal the terror I felt, so that I greatly contributed to inspire the rest with resolution; but the truth is, I gave myself over for a dead man, seeing the horrid fright the necromancer was in. The boy placed his head between his knees and said, "In this posture will I die, for we shall all surely perish." I told him that all these demons were under us, and what he saw was smoke and shadow; so bid him hold up his head and take courage. No sooner did he

"Agnolino, upon these occasions a man should not yield to fear, but should stir about and give his assistance, so come directly and put on some more of these." The effects of poor Agnolino's fear were overpowering. The boy hearing a crepitation, ventured once more to raise his head, when, seeing me laugh, he began to take courage, and said "that the devils were flying away with a vengeance."

"'In this condition we stayed till the bell rung for morning prayers. The boy again told us that there remained but few devils, and those were at a great distance. When the magician had performed the rest of his ceremonies, he stripped off his gown and took up a wallet full of books which he had brought with him.

"'We all went out of the circle together, keeping as close to each other as we possibly could, especially the boy, who had placed himself in the middle, holding the necromancer by the coat, and me by the cloak. As we were going to our houses in the quarter of Banchi, the boy told us that two of the demons whom we had seen at the amphitheatre went on before us leaping and skipping, sometimes running upon the roofs of the houses, and sometimes upon the ground. The priest declared, that though he had often entered magic circles, nothing so extraordinary had ever happened to them.

"'Whilst we were engaged in this conversation, we arrived at our respective houses, and all that night dreamed of nothing but devils.'

"Although Cellini declares that he was trembling with fear, yet it is quite evident that he was not entirely ignorant of the machinery which was at work, for in order to encourage the boy, who was almost dead with fear, he assured them that the devils were under their power, and that 'what he saw was smoke and shadow.'

"Mr. Roscoe, from whose life of Cellini the preceding description is taken, draws a similar conclusion from the consolatory words

as they were going home to their houses in the quarter of Banchi, two of the demons whom we had seen at the amphitheatre went on before us leaping and skipping, and sometimes running upon the roofs of the houses, and sometimes upon the ground.'"

We could hardly, in this enlightened age, attain to the brilliant success of frightening a "pure immaculate boy" out of his senses with "smoke and shadow," even were it a laudable undertaking. The delirium tremens, in a somewhat similar way, will doubtless continue to be hard on older and wayward boys who take to their cups, but be it ours to please and instruct, and that, in a more excellent way. A jet of steam could be conveniently arranged for the "ghost" experiment, but for the most part, a wet screen is better than smoke, and effects, not only startling, but truly beautiful, can be produced in the way described.

CHAPTER IV.

PICTURE SLIDES.

A LARGE number of movable slides, and some others of value, are still painted entirely by hand, but the great part of simple slides now in market are produced by photography.

There are two classes of photographic transparencies

globe, the physical peculiarities of every country, together with lifelike portraits of their inhabitants, and the form and arrangement of their dwellings, may be obtained in miniature, and reproduced as large as life.

Photographs of the sun and moon in various phases, and partially and totally eclipsed, also the fixed stars and nebulæ, have been obtained and employed for lecture illustrations. Enlarged photographs of microscopic objects have also been obtained, and these again still further enlarged to 8 or 10 feet in diameter, so that, in fact, a diatom no larger than a grain of sand may be shown of such a size in the lecture-room that a large audience may together examine its details with perfect comfort. The productions of the most celebrated painters and sculptors may be shown with equal facility, as well as maps, hymns, music, &c., so that an entire school may learn or sing together.

THE STANDARD SIZE FOR LANTERN SLIDES.

The ordinary wooden frame for the lantern picture is 7 inches long, 4 inches wide, and $\frac{3}{8}$ of an inch thick, with a circular opening of $3\frac{1}{4}$ inches to admit the picture-glass and its protecting glass cover, and 3 inches in the clear. Pictures $3\frac{1}{4}$ inches square are also mounted in frames of the same size, leaving 3 inches square in the

and for handling, and which in turn gives assurance of their being inserted in proper position.

Fortunately each half of a stereoscopic view is 3 inches square, so that lantern slides, of standard size, can be printed by contact from stereoscopic negatives. Although the demand for lantern slides has never warranted extensive travel for desirable negatives, yet the stereoscope has sent photographers "viewing" high and low, and everywhere; on the Alps, in the Yosemite, in the valley of the Nile, on open Polar Seas, and often (as intimated by one of their own number) into distressingly *narrow straits.*

Glass transparencies made for the stereoscope, when cut in two, with clear glass covers instead of ground-glass, are extensively used for lantern slides. Many of these, especially of the imported views, are very fine, and leave nothing to be desired when used in the Sciopticon. But as a heavy deposit of silver is not particularly objectionable in the stereoscope, many of these pictures can only be satisfactorily shown upon the screen, with an intense chemical light, if with that even. When the demand for these fine views for the lantern is sufficient to turn the attention of photographers to their production, we may look for more good pictures, and we hope at a cheaper rate.

THE SEALED PICTURE.

clear, and protects it from dust, and especially from any fluid that might accidentally reach the edges of the glass. All the circular pictures, except the movables, at a price of over two dollars, are sealed.

STATUARY.

This class of pictures should be photographed directly from the statuary, or bas-relief, by a skilful artist, who

shows the size of the round glass, and also the appearance of one of the most popular slides of this class. A female figure is seen floating down to earth; around her forehead is a wreath of poppy, indicating sleep; in her arms are two sleeping children (Sleep and Death); and in their company is the symbolic owl.

THE SLIP SLIDE.

Fig. 19 represents a class of movable slides most in use for amusement; being cheap, easily operated, and in shape to pack with ordinary slides.

In the slide represented, a peacock without a tail is painted on the immovable glass, and two tails are painted

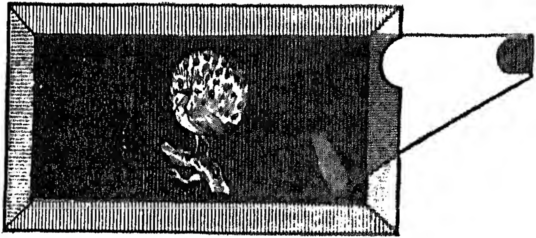


Fig. 19.

on the slip. Both glasses are blackened except where the picture is to show; when the slip is pushed in, the

the Sciopticon, the operator has hold of a slip with each hand, so he can jerk the rat back with a sudden movement of the forefinger, when he is all ready to make his appearance again as a new individual. In politics he might be called a "repeater."

THE LEVER SLIDE.

Fig. 20 represents another popular, but a more expensive, mechanical effect. The horse having approached the water with his head up, the lever to the right is raised, and the horse is "*made to drink*" (the old adage to the contrary notwithstanding). The head and neck

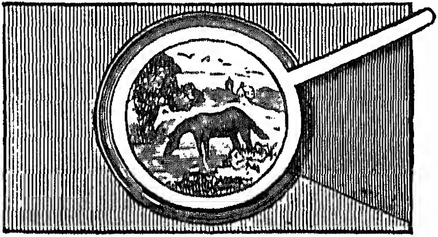


Fig. 20.

being painted on the glass moved by the lever, works up and down as on a pivot at the shoulders.

REVOLVING FIGURES.

appears in operation.

THE CHROMATROPE.

Fig. 21 represents the pulley form of the chromatrope, but can give no idea of the dazzling brilliancy of the effects it produces on the screen. There is nothing it resembles so much as the kaleidoscope, with the addition of constant motion and rapid change. It consists of two disks of glass, painted with an almost endless variety of geometrical and other designs in brilliant colors. By turning the handle shown in the figure, the multiplying band causes the rapid revolution of one disk over the other, producing two apparent motions; and with good designs the result "beggars all description."

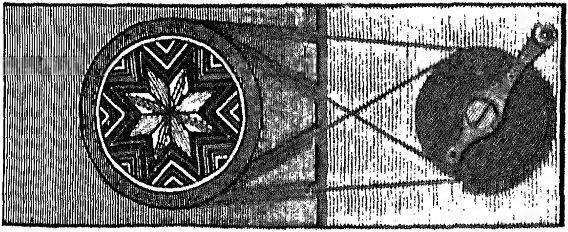


Fig. 21.

In another form the motion is accomplished by means

precisely similar to the chromatrope, are made to revolve one over the other. The effects are so beautiful as to excite surprise that they should be obtained by a mechanical contrivance of such extreme simplicity. By slow revolution, hexagonal, octagonal, and other geometrical figures are obtained, with delicate gradations of shadow; while a more accelerated motion produces the effect of stellate flashings, or scintillations of light. Color may be imparted by the use of tinted films of gelatine. Larger disks can be pivoted to a frame above the condenser so as to give an upward and outward movement to the scintillations as from a lower fountain. Stiff paper disks turned contrary ways by the hands at their edges will answer for practical experiments.

MOVING WATERS.

Under this title two forms of slides are sold; by means of which, in a single or double lantern, very pleasing effects may be produced. In the simplest form a moonlight scene is painted on a fixed disk, and the "rippling waters" on a piece of glass attached by one corner only to the framework of the slide, which being moved up and down causes the appearance of a ripple on the water.

Another more expensive, but more truthful effect, is produced by a slide having two movable and one fixed disk of glass, and known as the "moving water with

generation. Many of them hardly deserve attention, but some Nursery Tales, Natural History, &c., are fair, and the Astronomical set, in particular, is excellent.

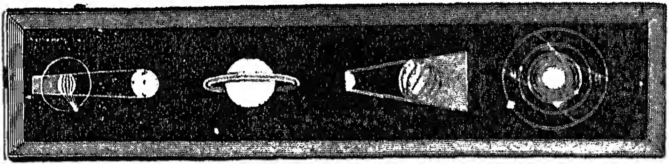


Fig. 22.

This set of ten astronomical slides, with forty-one illustrations, together with a set of astronomical diagrams with rack-work motion, makes a very complete outfit for a series of astronomical lectures.

DIORAMIC PAINTINGS WITH MOVING FIGURES.

In the middle of a glass strip (shaped and framed as in Fig. 22), a scene is painted, the rest being made opaque. Another glass strip, of similar size and shape, on which is painted along its whole length whatever is befitting, as figures, boats, &c., is made to pass in front in grooves, so as to represent a long procession; of this class, the children of Israel passing through the Red Sea is an example; or, the enterprising smugglers secreting contraband goods in the smugglers' cave.

presence is not suspected. A "woman in white" stands down in front, concealed from the spectators by the usual board near the orchestra, and is highly illuminated by the light from a magic lantern. The spectators, in the darkness and distance, see the actors upon the stage *through* the glass, and also the *ghost* reflected *from* the glass so as to appear on the stage with the rest. The actors do not see the spectre, but they put on the appearance of fright for the *benefit* of the spectators.

The apparition vanishes as the light is withdrawn from "the woman in white." The lantern is used because it illuminates an object without diffusing light in other directions.

On this principle we may see people in a room through a window, with the reflected images of parties outside standing among them. It seems not a little surprising to see one person cutting through the space occupied by another.

THE TANK.

An excellent and cheap tank (similar to the one shown in Fig. 26), but with permanent clamps without screws, is now shaped so as to slide into the Sciopticon stage without drawing forward the extension front. As the space at the top is unobstructed, all sorts of experiments with it are easily managed. Living creatures encaged in it, in air or water, figure upon the screen in huge pro-

large assortment of slides is less of a necessity.

PRECAUTIONS ABOUT SLIDES.

The lantern exhibition has to be conducted in so obscure a light that the operator has to depend more on the sense of feeling than sight; it is therefore important that the slides should be in good condition and properly arranged beforehand, and that their titles and descriptions should be well fixed in memory.

A convenient box for carrying the slides, for arranging them in, and for showing them from, is constructed as follows: Two boxes of any desirable length, 7¼ inches wide and 4¼ inches deep, are hinged together, so that each serves as a cover to the other. This double box will hold the ordinary wooden mounted slides without waste of room, and when open will show their labelled edges in proper position and order.

In social gatherings, the exhibitor is often urged to bring out certain favorite pictures on call, which, in the hurry and darkness, is apt to disarrange the slides, so as to perplex the operator, and mar the beauty of the entertainment.

With careful management the box may close on properly arranged slides, at the close of the exhibition.

Photography.

GLASS POSITIVES FOR THE MAGIC LANTERN.

By John C. Browne.

Few entertainments for the amusement of children, as well as persons of mature years, give more real pleasure than exhibitions of the magic lantern. It is a never-ending source of pleasure, and doubly valuable to the disciple of photography, who by the aid of a few chemicals and very simple apparatus, can prepare interesting slides of local interest that will delight the home circle, and fully repay the small expenditure of time required for their manufacture. Every photographer has among his negatives many subjects, both portrait and landscape, that when printed upon glass will prove effective pictures for exhibition.

The object of this paper is to give in as few words as possible, plain directions for making positives on glass, suitable for the magic lantern.

Either the wet or dry process can be used. The former is more applicable in cases where it is necessary to reduce a negative to the proper sized positive required for the lantern. The dry method is used to advantage when the negative is of small size, and can be printed in contact. As all photographers are familiar with wet manipulations, we will consider that process first.

different sizes, it will be found convenient to arrange two cameras front to front (as will be seen in Fig. 23),

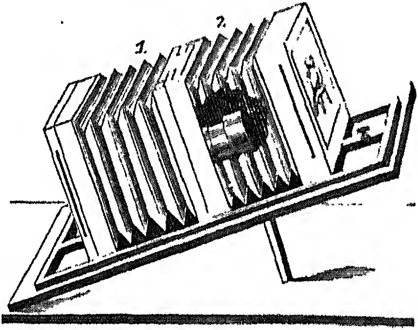


Fig. 23.

one camera having a lens in position with ground-glass No. 1; the other having the lens and ground-glass removed, and the negative that is to be copied placed in the position of ground-glass No. 3. The cameras, for convenience, can be closely joined together by screwing strips of wood upon each, which prevents any change of position when focused. By turning the rack-work upon each box, the picture upon the ground-glass can be made of any size.

This plan of using two boxes will be found to give perfect satisfaction; the negative and sensitive plates

In selecting a position for operations, a north light will be found the best suited for the purpose. The upper window sash should be lowered, and the board upon which the cameras are arranged rested one end upon a table, the other upon the lowered sash, so that the negative will have the sky for a background. This is easily determined by focusing upon the ground-glass. It is advisable not to allow the direct rays of the sun to illuminate the negative. Should a north light not be obtainable, cover a frame with white tissue-paper, and let that be the background for the negative. The tissue-paper can be illuminated with the sun's rays, or by any artificial light.

It may seem to the reading photographer, unnecessary to burden this article with a complete chemical formula for making glass positives, but as it is prepared expressly for the uninitiated, it would be unintelligible without a formula.

To make 8-oz. Sensitive Collodion.—Alcohol 5 oz., ether 3 oz., iodide of ammonium 44 grs., bromide of magnesium 20 grs., cotton (Parys') 35 grs. Before using, filter several times through cotton soaked in alcohol. It is a good plan to keep a supply of plain, unexcited collodion on hand, as a stock-bottle; also, a bottle of exciting solution, made in the proportion of iodide of ammonium 5 grains, bromide of ammonium 2½ grains, to the drachm

ounce of this solution add glacial acetic acid, 1 drachm. This can be used as a stock solution, and will keep an indefinite length of time in good condition. Crystals will form in the stock-bottle, after standing some hours, but that is of no consequence, as the strength of the solution is correct.

In developing a plate, use 5 drachms of water to 2 drachms of ammonio-sulphate of iron from the stock-bottle. During hot weather use ice-water to retard the action of the developer.

Fixing Solution.—Cyanide of potassium or hyposulphite of soda; either will answer, but the action of cyanide appears to make a somewhat brighter picture.

These solutions being carefully prepared, the picture accurately focused, the negative (collodion side towards the lens) covered with a dark cloth, prepare the plate in the dark-room in the usual manner, place it in the dark-holder, in the position of the ground-glass, draw the slide (the lens is always uncovered), remove the cloth from the negative for a few seconds. The exposure will then be made. Cover the negative, shut the slide, and remove to the dark-room for development. The picture should appear slowly; not flash out upon the first application of the iron solution. Over-exposure, as well as over-development, are both fatal to transparencies. No trace of fog should be visible. From five to fifteen seconds will be found sufficient

able to employ a very large negative. $6\frac{1}{2} \times 8\frac{1}{2}$ will answer the purpose better than a larger size. But negatives upon smaller glass will be found to give even finer results. On the other hand, it is very bad policy to attempt to enlarge a positive to double or treble the size of the original negative. The negative should not be smaller than the positive.

The Lens.—Any good portrait combination, of six to eight inches focus, quarter-inch stop, will work to advantage. Lenses of very short focus and very small opening, are not recommended.

The Development—Should be conducted with great care and judgment, as it is the most important part of the whole process. Rather under-expose and underdevelop, and as soon as the detail is visible, flood the plate with water, and check farther action. Avoid an excess of light during development, and dread the appearance of the slightest fogging as the worst enemy to be encountered.

Fixing Solution.—Cyanide of potassium, after which wash well in running water.

Toning.—It is frequently of benefit to the positive that it should be toned, and at the same time slightly strengthened, to give contrast to the picture when projected upon the screen by a powerful light. Many chemical solutions may be used to accomplish this purpose. A weak solution of gold gives good results; also, a dilute solution of

erful illumination, such as the oxy-hydrogen or magnesium lights are used, positives may be made slightly stronger, showing more contrast than where a weaker form of illumination is employed.

The slides should be protected from scratches and dust, by a piece of clear glass of the same size, neatly pasted on the edges with muslin.

Positives on glass can also be made by the wet process, from negatives of the proper size, by pasting a thin strip of cardboard upon two edges of the negative (collodion side). The sensitive plate is prepared as usual, and is placed, while in the dark-room, in close contact with the negative, separated only by the cardboard. It is then exposed behind the negative, to diffused sunlight or artificial light, for a few seconds, returned to the dark-room, and developed. This plan admits of no change in the size of the negative. Mr. L. J. Marcy's apparatus for printing wet plates by lamp-light, has given satisfaction to many who have not an opportunity of making experiments by daylight.

The proper size for glass pictures to be used in lanterns of convenient proportions, is a debatable subject. Glasses of 3¼ x 3¼ being generally used, but advantages are claimed for a slide 3¼ x 4¼, that have some weight. In placing this slide in the lantern, the additional length of the glass allows the corners to be held by the thumb

three.

A DRY PLATE PROCESS FOR LANTERN SLIDES.

TANNO-GALLIC PRESERVATIVE.*

In considering the dry process, it is but proper to say that a large number of different formulæ have been published; in fact, scarcely half a dozen photographers think alike on this subject. It is, therefore, impossible to give a formula that will give universal satisfaction. In preparing this paper for publication, it must be distinctly understood that nothing new in the way of preservative or development is claimed; it is simply one of the many methods for preparing dry plates that has given reliable results.

The dry-plate photographer must be prepared for many and great failures, and be possessed of the greatest amount of patience and nicety of manipulation, for otherwise time is wasted, and the best process voted a failure. Commence with reliable chemicals, and follow up the process with a lavish expenditure of water when washing is mentioned, not only on the collodion plate, but thoroughly rinse the various glasses and dishes, and particularly the *fingers*, between each operation. Use as little light as possible when making or developing dry plates, and be careful that the light is yellow.

Probably more dry plates are ruined, and the par-

low substituted, will be found very convenient; either gas, a candle, or kerosene can be used for illumination.

To prevent the collodion film slipping from the plate during the process, it is absolutely necessary that the glass plate should be albumenized. Wash the glass (having previously roughened the edges), drain, and while wet flow over it the following solution:

Albumen (the white of an egg), ...	1 egg.
Water, ...	1 pint.
Concentrated Ammonia, ...	10 drops.

Put the albumen in a clean bottle, then add the water. Shake a little, and add the ammonia; filter through a sponge; dry in a rack.

COLLODION.

Any reliable collodion will answer; it is best to have it quite thick. No backing is necessary.

NEGATIVE BATH.

Nitrate of Silver, ...	45 grains.
Water, ...	1 ounce.

Made slightly acid with nitric acid, C.P. Dip the collodionized plate in the bath, and when properly excited, remove the plate, and dip in a bath of pure water; then wash under a tap with running water. While wet apply the

PRESERVATIVE SOLUTION.

Tannin, ...	10 grains.
Gum Arabic, ...	" "

twice, working it well into the film; throw the first dose away, and use the second flowing for the first application to the next plate.

The plates must be carefully dried, either by natural or by artificial heat; a hot-water bottle will be found useful for that purpose should artificial heat be thought best.

THE EXPOSURE

Will depend upon the strength of the negative, and the nature of the light; a few seconds will generally be enough. *Close contact* is absolutely required to produce sharp positives. An ordinary printing-frame can be used.

TO DEVELOP

In a dark-room, remove the dry plate from the frame, place it in a dish, and flow over it

Alcohol, ...	equal parts.
Water, ...	

Then wash in running water.

DEVELOPING SOLUTIONS.

Pyrogallic Acid, ...	2 grains.
Water, ...	1 ounce.

Made from a stock-bottle of

Water,	. . . .	1 ounce.
Bromide of Potassium,	. . . .	4 grains.
Water,	. . . .	1 ounce.

Mix together.

After the plate is well washed, flow over it a solution of

Pyrogallic Acid,	. . . .	2 grains.
Water,	. . . .	1 ounce.

Then pour back again into the measure. Should the image be developed by this solution, proceed very cautiously, and add a few drops of the alkaline solution of carbonate of ammonia and bromide of potassium. If the picture comes out slowly, add more of the alkaline solution up to thirty drops, if necessary, and also a sufficient amount of stronger pyro to bring out all the detail. When the image is out, wash with water, and intensify with

Pyrogallic Acid,	. . . .	2 grains.
Water,	. . . .	1 ounce.

To which is added ten drops of citric acid and nitrate of silver solution.

Citric Acid,	. . . .	30 grains.
Nitrate of Silver,	. . . .	20 "
Water,	. . . .	1 ounce.

This is a stock-bottle. Mix in separate glasses; add together and filter; wash.

(From Humphrey's Journal.)

The following formula is not only used for opal pictures, but to some extent for transparencies also.

1. Take the whites of two eggs and two ounces of water, beat well to a froth, and let it settle for two hours and pour off the clear solution.

2. Coat your white plate with this solution (as you would with collodion), and set away to dry. When dry take in your dark-room and coat the plate with the "opal solution," which is made thus:

Plain collodion 8 oz. (thinner than you would use for iodizing), then dissolve in as little water as possible 60 grains nitrate of silver, and add this to the collodion and shake well. Then dissolve 16 grains of strontium in as little water as possible, and add this to the collodion and shake well. Then dissolve 10 grains citric acid in as little water as possible, and add to the collodion. Shake well, and you have the opal solution.

When dry, put your negative in the printing-frame, lay the opal-prepared plate on the negative, and print from 10 to 15 minutes in the sun, and print much darker than you would a photograph.

Tone and fix as you would a photograph, only you need not wash before toning—and wash but little before

with the sensitive plate, however widespread the light, or also *by having an intense light proceeding from a single point*, though the plates may be wide apart. In the latter case the point of light should be distant compared with the space between the plates, to avoid enlargement. A sharpness above criticism is produced by this printing apparatus, not by an absolute compliance with either condition, but by an approximate observance of both.

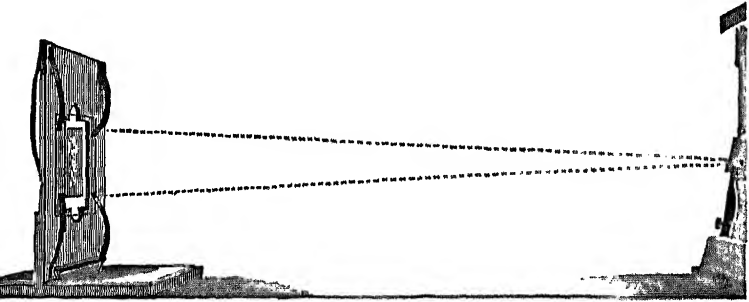


Fig. 24.

It consists of an upright frame in which the sensitive plate is held slightly separate from the negative, and a coal oil lamp, from which the light of a wide flat flame is emitted through a narrow horizontal slit—small and at considerable distance from the frame to produce a sharp print, and in range with the long diameter of the

strip of glass sets into this slit as between two lips. The thickness of the flame gives the horizontal diameter of the point of light. Only the front of the lamp is shown at the right of Fig. 24, but it can be seen how the light from the whole width of the flame reaches the printing-frame through the narrow aperture.

At the left, we see how the negative is held over the opening in the frame by four springs; the long spring on the opposite side holds the sensitive plate in the frame.

The operator, standing on the opposite side, with the upper corners of a quarter plate, just from the bath, between his thumb and finger, and shading off direct rays with his left hand, places it in its silver bearings; this brings the two films almost in contact.

The lamp and frame stand from 16 to 26 inches apart, or so far as to require about two minutes for the printing, or the time it takes for a round of the other manipulations and changes; so a picture is finished and dropped into grooves in a trough of water as often as one has had time to print.

All that is said in the previous article on the wet-plate process, in regard to development, &c., applies here. Any drops of silver bath that may have come in contact with the negative must be washed off before it is put away.

Like dry-plate printing, the negative must be of the

having clean glass, and chemicals in good working order.

6. The albumen coating is not required to make the film adhere.

7. The amount of exposure can be definitely gauged.

8. The illumination is confined to a narrow cone, so as not to fog the picture by diffused light.

9. The exposure is so immediate and uniform as to escape many accidents.

10. It is so easily done, that many causes of failure involved in a long process are not encountered.

11. The negative is not marred by use as in contact-printing.

12. This apparatus complete costs but seven dollars.

Thus we have in it advantages by the dozen.

THE SCIOPTICON PROCESS.

By placing the Sciopticon near a wall, in a dark room, and drawing forward its extension front, an image of a negative may be projected into a three-inch circle. First focus sharply on a paper-covered glass, and then expose a wet plate in the same place a minute, more or less, developing and fixing as usual, and we have a glass positive photographed by the Sciopticon for the Sciopticon.

The objective is always used with full opening, because all the light is needed, and because it will...

become a profitable branch of photography.

The toning of glass positives, to be used for ornamental purposes, involves some thought as to the particular color, or shade of color, that will suit the picture best; and it is impossible to give one process that will suit all tastes alike; some having a preference for black tones, others for blue-black, brown, or the various shades of gray. A detailed description of the manner of producing these various tones would require too much space, and is so simple that no one can go astray.

The principal chemicals required are: Chloride of gold, bichloride of platinum, bichloride of palladium, sulphide of potassium, and permanganate of potassium; in all cases use singly and very dilute. I am disposed to consider chloride of palladium as the most reliable chemical that has come under my notice. Its action is perfectly manageable, easy to prepare, will not stain, and gives uniformly good results. The toning solution that I use is made as follows: Add six drops from the stock-bottle of chloride of palladium to each ounce of water; this solution should be of a delicate straw color. No other manipulation is required. After the plate has been developed and fixed, wash as usual, then apply the toning solution by flowing it over the plate similarly to the developer. Its action will be quick, giving a black tone to the positive. Wash well, dry, and varnish if

the subject to be painted, it can be thrown upon the canvas of the size desired, and expeditiously and accurately traced. It saves valuable time to the good artist, and it prevents the poor artist from producing distortions.

WOODBURY PHOTO-RELIEF EXCELSIOR LANTERN SLIDES.

By JOHN C. BROWNE.

While it is a comparatively easy matter to produce fine positives by either the wet or dry process of photography, yet the results are liable to vary somewhat even in the hands of the most careful manipulator. The Woodbury photo-relief process, as now worked in Philadelphia, has the merit of distancing all competition in the uniform excellence of its lantern slides. It would be a pleasure to give in detail a description of this wonderful process, did space permit, commencing with the sensitive gelatine tissue, resembling in appearance a piece of patent leather, and following it in its exposure to light under a negative, the light's action rendering insoluble those parts reached through the negative; its subsequent immersion in hot water dissolves out those parts not rendered insoluble, producing a relief as thin

it before the glass is placed in position.

A slight pressure is given in a press of peculiar construction, squeezing out the surplus ink; a few minutes is allowed the ink to set, when the glass, being removed, brings with it the delicate gelatine picture, which is well named "Excelsior."

CHAPTER VI.

COLORING SLIDES.

WRITTEN FOR THE SCIOPTICON MANUAL.

THE magic lantern has caused much astonishment and delight from its origin to the present time. The pictures or slides for it were formerly drawn or painted on glass, and when magnified by the lantern lens, even the most minute lines looked coarse, and every imperfection was brought out. Much time and care, therefore, were requisite to make fine pictures, so that they were comparatively rare and expensive, while the coarser ones abounded; thus the lantern came to be regarded as a toy, fit only for the amusement of children. An instrument, however, so well calculated to aid in the

Photography, by its wonderful sun paintings on glass, reproduces the works of the old masters, furnishes views of every land and clime, of customs, manners, works of art, and pictures, or diagrams, to illustrate every science, the beauty of which, when colored and thrown upon the screen, however great the magnifying power used, is not diminished, as was the case with the paintings formerly used. With beautiful and desirable pictures, and with improved lights and instruments, the lantern now takes a front place. in Sunday-school work, in the school, the lecture-room, and the home, and is gladly welcomed wherever visible illustrations are used, or beautiful pictures prized. While the stereoscope presents the life-like photographs to the individual observer, the lantern enlarges the same views, so that many may see and enjoy at the same time the same beautiful scenes together, making it well suited to the social gathering and entertainment of friends. Families may have slides prepared containing pictures of family residences, of members of the family, of favorite dogs, horses, &c., thus increasing the pleasures of home, and social intercourse.

The coloring or painting of slides for the magic lantern has been confined to comparatively few artists, the great care and nicety of execution required, making it a difficult art to attain, while the old preparation of varnish colors placed difficulties in the way of even the most practiced artists.

yellow lake; for blue, Prussian blue and indigo; for red, madder lake, crimson lake, and scarlet lake; for orange, burnt sienna; for brown, madder brown, Vandyke brown, sepia, and burnt umber; for black, India-ink and lamp-black; for purple, purple lake, or red and blue mixed; for green, mix yellow and blue; for scarlet, red and yellow. A white porcelain palette, free from specks and grit, is the best upon which to mix and arrange the colors. Use soft water for mixing the tints. For cake colors, use a weak gum water, taking care to have it quite dilute to prevent the colors cracking or peeling off; place each tint on a separate slab or saucer.

A suitable easel for holding the glass to be painted, is shown in the diagram (Fig. 25); this is a sloping frame, holding a sheet of glass, so arranged that it can be placed at any angle, and any convenient height for the artist.

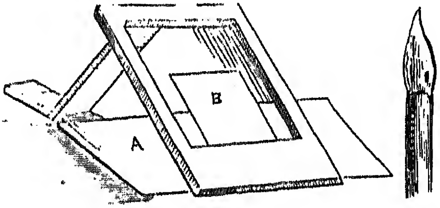


Fig. 25.

The glass or photograph to be painted, should be placed

drawing the finger-nail over the surface. The glass should be carefully cleaned with water, to which a solution of ammonia has been added. A fine brush, or cheap gold pen, may be used for drawing outlines, which should be made with colors suited to the part of the painting for which they are to be used; the foreground being drawn with bolder lines than those more remote.

One of the most difficult things to accomplish in transparent painting on glass, perhaps, is to lay on a uniform tint, free from lines or specks; as a clear blue sky without clouds. The brush should be well charged with the blue tint, and the color spread or floated upon the glass as evenly as possible, and afterwards equalized by a careful application of the brush dabber: that is a camel-hair brush cut down (as shown in Fig. 25), the edge of which being afterwards passed through a flame so as to remove any straggling hairs. The finger, also, may be used as a dabber, and when used with dexterity, is very effective. To take out the necessary lights, as those of clouds, and to soften the edges, a stump made of leather or paper may be used. In coloring photographs the outline and shading are provided; so that flat washes of color are to be laid on, and then retouched and improved; avoid covering the deepest shadows, thus destroying their transparency. Breathe on it sufficiently to moisten the colors, and carefully blend and harmonize the tints; commence with the sky, then the middle distance should

may be used for making minute touches of light, as on spears of grass; winter, snow, spring, and moonlight effects are produced chiefly by the skilful use of the knife and needle-points, to remove the color and produce strong white light in the picture. As pictures vary much in style, it would be difficult to give directions which would apply to all. Beginners should copy well-painted lantern slides at first, as this would guide in the colors to be used. Practice on waste pieces of glass and noting the effect in the lantern, would also prove beneficial and accustom the artist to regulate the tones of the picture in the best manner. When the picture is finished, it should be protected by a thin transparent varnish, such as photographers use, or a thin coat of Canada balsam. To prevent scratching, a glass, the same size as the picture, should be laid over it; and to prevent injuring from contact, a narrow rim of paper should be interposed between the glasses; they can then be bound or framed.

"Aniline colors have been used for photographic views with some success. They are brilliant and transparent, but require careful use to prevent the tints running one into the other."

Comic slides are often painted in a coarser manner, and oil paints are used. The method is very similar to

turpentine is used as a vehicle, sugar of lead as a drier. Comic or slip slides are generally painted on two pieces of glass, one of which is firmly fixed in the frame, the other movable; these glasses are so adjusted, that when the sliding glass is pulled out, an effect is produced which differs entirely from that shown when the glass is pushed in; as, for example, "The Windy Day;" the lady is seen passing along, fashionably dressed and equipped; the slip being drawn, she is shown in sad plight by the turned parasol, loss of false-hair, bonnet, &c.; or a beautiful lily or tulip is seen; the slip is drawn, and a lovely fairy seems to float up from the flower. Chromatropes are constructed of two circular pieces of glass painted from the centre to the circumference of the circle with variously tinted rays and patterns, these are framed in brass frames, having grooves around them turned face to face, and when made to revolve reversely throw out beautiful and brilliant hues; according to the way in which they are made to turn, they expand or contract.

Statuary gives a much better effect, if the glass around it is covered with some opaque paint. Lampblack ground very fine with mastic varnish, a few drops of oil of cloves, and then brought to the right consistency with turpentine, is perhaps the best, as it does not rub off. "Opaque," an article manufactured by Mr. Gihon,

through these lines appearing on the screen as a white chalk diagram on a blackboard. Still another way of preparing diagrams is to dissolve gelatine, such as is used in cooking; strain, and pour it over the glass, forming a thin film on its surface. When this is dry, the diagram is scratched on as before, and soft lead rubbed over the lines. Mottoes may be photographed on glass, and then colored, or the designs drawn with the pen or brush, and colored.

The Sciopticon is extremely well adapted for experiments and amusements, as its front lens can be drawn out, giving ample space for the introduction of figures and such like. Small china and wooden dolls, with but slight tissue-paper dress, may be made to twirl or move about in many curious ways; those with perfect faces are the best. They of course must be suspended by a silk or wire attached to the foot; but a hint is sufficient. Lizards, fish, and insects in the tank are always pleasing because they move. When one has but few slides, the entertainment may be varied by introducing some of the home-made objects, thus affording much amusement, with but slight expense and trouble.

CHAPTER VII.

CHEMICAL EXPERIMENTS.

be secured.

For this purpose there is needed in the first placed the simple apparatus shown in our wood cut, consisting of a small tank, made by securing two plates of glass, about 4 x 5 inches, with four clamps, against a strip of rubber about ¼ inch thick, bent into the three sides of a rectangle and notched at the corners to facilitate its bending.

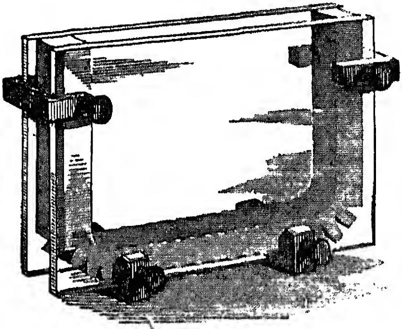
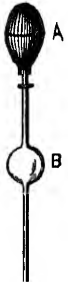


Fig. 26.

We then require one or more glass pipettes provided with elastic balls, such as are made by the rubber manufacturers. This little apparatus is shown in Fig. 27, where A is the rubber ball, B the glass globe of the pipette, and C its point drawn to a moderately fine orifice.



A few small pipettes made by simply drawing short pieces of glass tube to a fine point, are also useful.

In addition, a few bottles with such ordinary chemicals as will be mentioned further on, will complete the outfit.

observe the progress of the effect. On the screen will be observed the gathering of a tempest of black storm-clouds, which twirl around in violent commotion, as if urged by a tornado of wind, but as the action continues, these clouds will melt away, and leave the entire field of a serene and beautiful sky-blue.

By now throwing in some diluted sulphuric acid, the same changes can be reproduced, and so on alternately for a number of times. Then when the tank is clear, with an excess of acid, let fall a few drops of a solution of ferrocyanide of potassium from a small pipette, and rich red curdled clouds of ferrocyanide of copper will form with a beautiful appearance.

Experiment 2d. Having rinsed the tank, or taken a fresh one with water in it as before, add to this some solution of litmus, until the whole acquires a purplish-blue tint. Now throw in very gently a little very dilute acid, and allow it to diffuse. On the screen will appear the image of a beautiful sunset sky, with its changing tints of drifting clouds.

When all has changed to red, add ammonia, and so reverse the change, which may then be repeated.

Experiment 3d. Proceed exactly as in the last case, but with a solution of cochineal in place of litmus. The red color will then be changed by the acid to a brilliant yellow, and by ammonia to a rich purple.

Experiment 5th. Make a concentrated solution of crystals of urea in alcohol of about 95 per cent. (The common 85 per cent. alcohol will not answer.) Let a few drops of this fall on a glass plate, and with the finger spread it rapidly over the surface, and then at once place it as an object in the lantern. After about a minute, blow gently on the plate with a bellows (not with the breath), and at once on the screen will be seen the growth as of frost crystals shooting over the field in all directions.

Experiment 6th. If sulphate of copper in solution is mixed with enough gum-arabic water to make the solution form a continuous film, when flowed like collodion on a clean glass, and such plates are allowed to dry slowly in a nearly horizontal position, a very beautiful crystalline vegetation will set in, which varies in its character with the proportion of gum used, and will make objects well fitted for exhibition with the lantern.

In place of sulphate of copper, we may use nitre, or ferrocyanide of potassium, with the production of an entirely new class of forms.

By placing the plates so covered with crystals over a leaden dish, in which is a little fluor-spar, moistened with sulphuric acid, and warmed slightly (giving off fumes of hydrofluoric acid), permanent etchings may be prepared, which are also very beautiful objects for the

tion with a galvanic battery. It is the most convenient for the preceding experiments, as well as for those which follow.

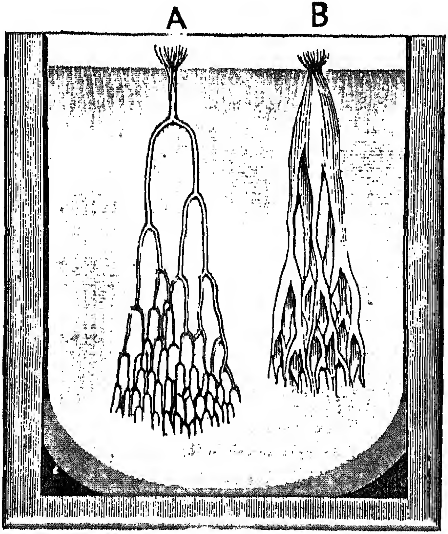


Fig. 28.

Cohesion Figures.—The cohesion figures known as Tomlinson's are both interesting and beautiful, and can be shown as follows: Fill the tank to within half an inch of the top with alcohol and slide it into place upon

half an inch or so, and then break out into two branches; these again will break in four, and so on, until by the time the dye gets to the bottom of the tank it will have formed some hundreds of delicate branches. As this action is reversed on the screen, the branches appearing to shoot upwards, the effect is much heightened. *A* (Fig. 28), shows the form assumed. By placing at intervals of half an inch drops of different colors, as their branches commingle, the effect reminds one of a shower of different colored rockets. If we now take another tank, and fill it with coal oil, and put a drop of fusel oil into it, we get an entirely different figure, as shown at *B*. The fusel oil is best colored.

Capillary Attraction can be strikingly shown to a large audience. A series of glass tubes of different sizes are fitted into a piece of wood which rests on the top of the tank, and dips down to near the bottom; when the tank is filled with water, which is best tinted, the different heights of the water, according to the fineness of the tubes, will be shown clearly on the screen. The curve shown by the liquid rising between two pieces of glass can be shown in the same manner, the colored water forming a pretty gradation of color between the highest and lowest part.

Crystallization.—By filling the tank with a satu-

THE DEVELOPMENT OF A PHOTOGRAPH ON THE SCREEN. —For this we require a tank with one of its faces of yellow glass, which side should be next the condenser. Place a small statuette in the rays of the lantern, and having prepared a small plate with collodion and sensitized it, expose in the camera for about a minute; then, having filled the trough with developing solution, place in it the slide, and as the development proceeds the image will gradually appear on the screen. A transparency might then be made from this, and, after drying, shown on the screen, thus illustrating the formation of a photographic lantern slide.

CHANGING COLORS.—A glass coated with a mixture of gelatine and chloride of cobalt, when placed in front of a slide, will give a rosy effect to the picture, which, however, from the effect of the warmth of the lantern, will gradually change to purple and then to blue. On becoming damp again it will resume its red color, and can be used over and over again.

COMPLEMENTARY COLORS.—A number of beautiful effects, showing complementary colors, may be obtained with the Sciopticon. If we insert a piece of green glass, having any design cut out of black paper and pasted on it, we shall see on the screen a black design on a green

Fairy Fountain.—The effect of what is known as the "Fairy Fountain" can be prettily illustrated in the following manner: A small table fountain is placed at a distance of about four feet in front of the lantern; by curtains or otherwise the lantern is then hidden from the spectators, so that they see only the fountain illuminated by the rays coming from the lantern. When the fountain is made to play, every drop seems transformed into a diamond, and by passing colored glass in front of the lantern the effect is striking and beautiful; but when the rays from a bisulphide of carbon prism are allowed to fall on it, then is the best effect produced.

The Rainbow.—A card with a curved slit, one-sixteenth of an inch (Fig. 29), will throw on the screen a simple semicircle of white light; but when a prism is held in front of the objective, the bow at once assumes all the natural colors of the rainbow. As the direction of the rays is changed, the range of the instrument has to be elevated, to bring the bow upon the screen. By using two lanterns, projecting a view with one and the bow

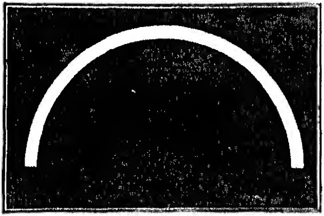


Fig. 29.

above the poles in the lantern; then allow iron filings to fall gently down the funnel, which will appear like large blocks attracted upward by a huge magnet.

Astronomical Cards.—The cards may be cut to the size of the crystal slide, that is $3\frac{1}{4}$ by $4\frac{1}{4}$ inches, so as to be used in the grooved frame, like an ordinary glass slide. After correctly dotting a constellation of stars (which may be done by the use of theorem paper and a good map of the heavens), pierce the card at the several points, say with a darning needle, which may be made to show stars of different magnitudes by gauging the depth of the insertion.

To illustrate the Solar System, punches of different sizes might be used and bits of colored gelatine, covering the aperture, might indicate the tints attributed to each member.

Pinhole Outlines.—Cards in shape of glass slides and just thick enough to be sufficiently stiff, may be pricked to show maps, mottoes, figures, diagrams, or any simple illustration. They require but little skill and show very distinctly.

Perforations.—Two pieces of perforated paper or tin made to slide little by little over each other, in front of the condenser, and modified more or less by the

(having one or more slits cut in it) revolving in the place where the slide is placed, and also a larger one placed at some distance—the latter representing a wheel, the spokes of which are painted in black on a sheet of white cardboard. When this is made to revolve rapidly in the rays coming from the lantern, all trace of the spokes will be completely lost; but on causing the small disk to revolve at nearly the same speed as the larger, the latter will appear to be moving slowly, although moving rapidly, and by increasing the speed of the smaller wheel, the larger will gradually appear to slacken in speed until it appears to be motionless, and then apparently begin to move in an opposite direction to which it is really revolving.

SILHOUETTES, &c.—Paper patterns, silhouettes, &c., suspended by a thread attached to the feet, and twirled before the condenser, give a very amusing and curious effect.

GALVANIC ACTION.—Fill the tank with a solution of nitrate of silver, and introduce at each end two wires from a small battery; from one of the wires a beautiful silver tree will immediately begin to grow. The experiment may be varied by substituting acetate of lead for a lead tree.

Litmus solution, neutralized, will gradually redden around one point, while around the other it will assume

as huge monsters upon the screen, and excite a lively interest by their eccentric movements.

Drawings are quickly put on glass by coating or rubbing the glass with soap. The surface is half-transparent. The drawing is made with a sharpened piece of wood, and appears then in clear light It is very easy to remove this drawing, like a drawing on a slate

India ink, mixed with rain water to a thick mass will stick on non-prepared glass

Designs may be nicely etched upon glass by first coating the glass with a thin, even coat of beeswax, which can be well done by heating the glass over a lamp until the wax melts and flows over its upper surface. When it is cool, draw the design with a needle-point or a small awl, cutting through the wax all the way Take an old saucer or some such dish which you are willing to spoil for other use, and put into it a tablespoonful of powdered flourspar. Upon that pour a tablespoonful of strong sulphuric acid, and stir them together with a stick. Fasten the glass, the drawing uppermost, to a piece of board large enough to completely cover the dish The fastening can be done by crowding tacks into the wood, so that the heads shall lap the glass and keep it in its place When thus fixed and laid over the mixture of spar and acid, gently heat the dish, being careful not to inhale the fumes that will escape When the fumes begin to appear, put the whole either out

on the screen in varied [illegible] of form.

Touching the surface with the point of a fine wire will start the waves in circles. Vibrations effected by drawing a fiddle bow across the edge are seen to vary according to the different tones produced.

Adhesion Figures.—Drops of various oils upon the surface of the water, essential oils for instance, will exhibit various interesting adhesion figures, each oil assuming some peculiar form of outline.

Magnetic Curves.—A thin bit of magnetic steel, say three-fourths of an inch long by one-eighth wide, cemented on the under side of a glass plate, will attract fine iron filings scattered upon the plate into curves, illustrating the deviation of the magnetic attraction at either pole and the neutral axis in the centre of the magnet. A few taps on the glass will assist the arrangement.

CHAPTER VIII.

Descriptive Lectures.

CONCERT EXERCISES.

In the absence of special provisions for supplying this demand, some general hints in this direction may here prove acceptable.

In some assemblages (possibly in some Sunday-schools), very little can be said to advantage on account of the prevailing noise and confusion. The exhibitor having (for love or money) accepted the situation, the question arises as to how to make the best of it.

In such cases in particular it is politic, as well as proper, to select slides unexceptionable in their influence. Grotesque and ridiculous representations gratify a depraved taste, and render a demoralized company still more unruly. It is better to please by what is strikingly excellent and beautiful.

Without assuming the attitude of a reformer, one may take advantage of the lull of expectancy preceding a change of scene to give in a natural voice some interesting particulars of the forthcoming picture.

> "Your mystical lore,
> As coming events cast their shadows before,"

will be respected, and you may be able, by judicious management, to strengthen your position on vantage ground. Even in a civilized assembly (and we may well hope to find ourselves in no other), some tact is needful, as well as agreeable speech and faultless manipulation.

essary its several parts, and then repeat the Scripture which is illustrated.

Take, for example, Adam and Eve in Paradise; the luxuriant foliage, the lion, the ox, the horse, the birds, and alas! the subtle serpent.

"In the beginning God created the heaven and the earth.

"And God said, Let us make man in our image, after our likeness; and let them have dominion over the fish of the sea, and over the fowls of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth.

"So God created man in his own image; in the image of God created he him; male and female created he them.

"And the Lord God planted a garden eastward in Eden; and there he put the man whom he had formed." Gen. 1: 1, 26, 27; 2: 8.

Or take the scene where Joseph presents his father to Pharaoh. Mark the postures of each, and consider the manners of the times.

"And Joseph brought in Jacob his father, and set him before Pharaoh; and Jacob blessed Pharaoh. And Pharaoh said unto Jacob, How old art thou? And Jacob said unto Pharaoh, The days of the years of my pilgrimage are a hundred and thirty years: few and evil have the days of the years of my life been, and have not attained unto the days of the years of the life of my fathers in the days of their pilgrimage. And Jacob blessed Pharaoh, and went out from before Pharaoh."—Gen. 47: 7, 8, 9, 10.

Thus Scripture, to any desired extent, may be readily selected appropriate to any Bible picture...

In this modern institution, as elsewhere, there are many duties to be performed, and more ways than one of doing each of them. We will indicate, in this connection, one way of using the Sciopticon. Each member of the school takes a small moneyed interest in the concern at the outset, which insures his taking a more lively interest in the success of the enterprise afterwards.

The apparatus is strictly in the hands of an authorized keeper, because lax regulations suppress all genuine enthusiasm.

The operator arranges his slides in proper order and position, and so is able to avoid ridiculous blunders. His characters are introduced on time, steady and upright, and his scenery glides into place as if seen from the deck of a moving steamer.

It is good policy to enlist as many pupils as possible into active service, thus incidentally enlisting the sympathies of as many circles of relatives and friends.

Suppose repentance is the theme, and the "Prodigal's Return" is illustrated upon the screen. A pupil, fully prepared, stands in his place and recites the whole parable as found in Luke 15.

Another pupil, rising in his class, recites:

"Therefore also now saith the Lord, Turn ye even to me with all your heart, and with fasting, and with weeping, and with

Is. 55: 7.

Passages bearing on repentance and forgiveness are very numerous, from which selections can be made to any extent desired. Illustrations with fewer relations to parallel passages may be coupled with others to extend the exercise to proper length.

Selections also from modern writers, well rendered, give pleasing variety and artistic effect to the performance. The sacred poems of N. P. Willis, for example, are very appropriate. The following extracts may serve as specimens:

ABRAHAM'S SACRIFICE.

. . . . He rose up, and laid
The wood upon the altar. All was done.
He stood a moment, and a deep, quick flush
Passed o'er his countenance; and then he nerved
His spirit with a bitter strength, and spoke
"Isaac! my only son!" The boy looked up.
"Where is the lamb, my father?" Oh, the tones,
The sweet, familiar voice of a loved child!
What would its music seem at such an hour?
It was the last deep struggle. Abraham held
His loved, his beautiful, his only son,
And lifted up his arm, and called on God,
And lo! God's angel stayed him — and he fell
Upon his face, and wept.

The Saviour's hand, and fixing her dark eyes
Full on his beaming countenance, AROSE!

CHRIST WEEPING OVER JERUSALEM.

. . . How oft, Jerusalem! would I
Have gathered you, as gathereth a hen
Her brood beneath her wings, but ye would not!

He thought not of the death that he would die—
He thought not of the thorns he knew must pierce
His forehead—of the buffet on the cheek—
The scourge, the mocking homage, the foul scorn!
Gethsemane stood out beneath his eye
Clear in the morning sun, and there he knew
While they who "could not watch with him one hour"
Were sleeping, he should sweat great drops of blood,
Praying the "cup might pass." And Golgotha
Stood bare and desert by the city wall,
And in its midst, to his prophetic eye,
Rose the rough cross, and its keen agonies
Were numbered all—the nails were in his feet—
The insulting sponge was pressing on his lips—
The blood and water gushing from his side—
The dizzy faintness swimming in his brain—
And, while his own disciples fled in fear,
A world's death-agonies all mixed in his!
Ay—he forgot all this. He only saw
Jerusalem—the chosen—the loved—the lost!
He only felt that for her sake his life
Was vainly given, and, in his pitying love,

Christ," "The Widow of Nain," "The Raising of Lazarus," "Christ's Entrance into Jerusalem," and "Scene in Gethsemane."

The following poem, by an author unknown to us, will be inserted entire, as it so vividly portrays the mind of the parent and the love of the Saviour for children, and so graphically describes the picture of "Christ Blessing Little Children:"

"The Master has come over Jordan,"
  Said Hannah, the mother, one day;
"Is healing the people who throng Him,
With a touch of his finger, they say.

"And now I shall carry the children,
  Little Rachel, and Samuel, and John;
I shall carry the baby Esther,
  For the Lord to look upon."

The father looked at her kindly,
  But he shook his head, and smiled;—
"Now, who but a doting mother
  Would think of a thing so wild?

"If the children were tortured by demons,
  Or dying of fever, 'twere well;
Or had they the taint of the leper,
  Like many in Israel."

Will follow them as they go."

So over the hills of Judah,
  Along by the vine-rows green,
With Esther asleep on her bosom,
  And Rachel her brothers between;

'Mong the people who hung on His teaching,
  Or waited His touch and His word,
Through the rows of proud Pharisees listening,
  She pressed to the feet of the Lord.

"Now why shouldst thou hinder the Master,"
  Said Peter, "with children like these?
Seest not how from morning till evening
  He teacheth, and healeth disease?"

Then Christ said, "Forbid not the children:
  Permit them to come unto Me,"
And He took in His arms little Esther,
  And Rachel He set on His knee.

And the heavy heart of the mother
  Was lifted all earth-care above,
As he laid His hand on the brothers,
  And blessed them with tenderest love.

And He said of the babe in His bosom,
  "Of such is the kingdom of heaven,"—
And strength for all duty and trial,
  That hour to her spirit was given.

her Children," are much used in connection with the corresponding slides. These published exercises afford practical hints, applicable also to Bible slides.

Singing should be introduced at every convenient opportunity, not only for its general good effect, but that each individual may participate directly in the exercises.

Texts of Scripture, and other selections, recited in this way at the rehearsals, and at the concert, become fixed in the memory of all. Who cannot remember such recitations heard in childhood, even to the tones and inflections of the voice—of voices, maybe—not now heard among the living?

These modest recitations require no parade upon an illuminated rostrum; an occasional omission is not very noticeable. The exercises can be arranged by the superintendent, divided among the teachers, assigned to the pupils, and committed to memory by them without severe labor on the part of any.

One or two slides for the concert exercise, with, say a dozen or so for subsequent recreation, answers the purpose. Such a concert exercise, well gotten up, may be several times repeated with growing interest.

It often occurs in schools, where the burdens and duties are monopolized by the few, that the many be-

The following descriptions are selected from the "Bible Dictionary," "Bible Lands," "The Land and the Book," "Bayard Taylor's Travels," &c., to suit the slides in Class III.

As works on Egypt are less common than the Bible Dictionary, a description of each of the twenty Egyptian views is given.

JERUSALEM.

(For description of the City, and view from Mount of Olives, see Catalogue, Class III.)

THE TEMPLE AREA.—The Temple Area, the precincts known to Christians as the Mosque of Omar, but called by the Moslems the "Dome of the Rock," the harem more sacred to Moslems than any spot on earth, except Mecca, is jealously guarded by the Turks. It contains about thirty-five acres, a large portion of which is sprinkled with pomegranates and cypresses, with here and there a shrine. Above this space rises the platform of the great mosque, paved with marble, and ascended by a flight of white marble steps, surmounted by a beautifully carved screen or open gateway, also of white marble. The edifice is an octagon of about one hundred and seventy feet diameter. There are four doors at the opposite cardinal points. The dome is sustained by four

centre of the world, suspended from heaven by an invisible golden chain. It is a mass of the native rock of Moriah, the sloping summit or peak of the hill; all the rest of the ridge was cut away when levelling the platform for the temple and its courts.

THE TOWER OF HIPPICUS.—The only castle of any particular importance is that at the Jaffa Gate, commonly called the "Tower of David." The lower part is built of huge stones, roughly cut, and with a deep bevel around the edges. It is believed by many to be the Hippicus of Josephus, and to this idea owes its chief importance, for the historian makes that the point of departure in laying down the line of the ancient walls of Jerusalem.

THE CHURCH OF THE HOLY SEPULCHRE.—The Church of the Holy Sepulchre is now in the joint possession of all the Eastern Christian sects. Greeks, Latins, Armenians, and Copts have each a chapel within its inclosures, which embrace the alleged sites of the place of the crucifixion and the tomb of the Redeemer. It has been built at many different periods, and under various circumstances.

"The front is a fine specimen," says Lord Nugent, "of what is called the later Byzantine style of architecture." As lately as 1808, the whole of the principal

THE JEWS' PLACE OF WAILING.—No sight meets the eye in Jerusalem more sadly suggestive than the wailing-place of the Jews, in the Tyropean, at the base of the wall which supports the west side of the Temple Area, where some ancient stones still mark the old walls of the temple. In past ages the Jews have paid immense sums to their oppressors for the miserable satisfaction of kissing these stones, and pouring out lamentations at the foot of their ancient sanctuary. With trembling lips and tearful eyes they sing: "Be not wroth very sore, O Lord, neither remember iniquity forever; behold, see, we beseech thee, we are all thy people. Thy holy cities are a wilderness; Jerusalem is a desolation. Our holy and beautiful house, where our fathers praised thee, is burned up with fire, and all our pleasant things are laid waste."

THE GOLDEN GATE AT JERUSALEM.—In former days the gates of towns were of the utmost importance; they were the means of ingress and egress, and usually had rooms over them, and, above these, watch-towers, so that the approach of an enemy might be seen beforehand. The Golden Gate, in the east wall of the Temple Area, is ancient, and the interior of it ornamented with rich and elaborate carving in good Grecian style. It is now walled up.

our Lord often resorted with His disciples. At present a modern garden marks the site of the ancient one with eight venerable olive trees, which some claim grew there in the Saviour's time. It has been argued that Titus cut down all the trees about Jerusalem. The probability would seem to be that they were planted by Christian hands to mark the spot; unless, like the sacred olive of the Acropolis, they may have reproduced themselves.

BETHLEHEM.—Bethlehem was in existence when Jacob returned from his long sojourn in Padan Aram. Here Rachel died. It was in the neighboring fields, in later times, that Ruth, the Moabitess, went gleaning when she came with her mother-in-law, Naomi, to dwell in the land of Israel. It was the birthplace of David, but is best known to us as the birthplace of the Redeemer, great David's greater son and Lord. "On the plains near were the shepherds abiding in the fields, and keeping watch over their flocks by night, when lo! the angel of the Lord came upon them, and the glory of the Lord shone round about them, and they were sore afraid. And the angel said unto them, Fear not, for behold, I bring you good tidings of great joy, which shall be to all people; for unto you is born this day, in the city of David, a Saviour which is Christ the Lord."—Luke 2: 8–11.

commandment to his sons, "Bury me with my fathers in the cave that is in the field of Ephron, the Hittite. There they buried Abraham and Sarah his wife. There they buried Isaac and Rebekah his wife, and there I buried Leah." And his sons did unto him according as he commanded them, and buried him in the cave of Machpelah. The massive walls of the harem or mosque, within which the cave lies, forms the most remarkable object in the whole city. Hebron now contains about 5000 inhabitants, of whom some fifty families are Jews. It is picturesquely situated in a narrow valley, surrounded by rocky hills.

"The Pool of Siloam" is one of the few undisputed localities in Jerusalem, still retaining its old name. It is of no considerable size, being eighteen feet broad and nineteen deep. It is, however, never full, having in it usually about four feet of water. It is a complete ruin. It was to this pool that our Lord sent the blind man, after he had anointed his eyes with clay. It was to Siloam that the Levite was sent with the golden pitcher on the last day of the feast of Tabernacles, and from it he brought the water which was then poured over the sacrifice, in remembrance of the water that flowed from the rock Rephidim.

Genesaret, or Sea of Galilee.—This view exhibits

filled the nets, so that they brake; walked on the waves, rebuked the winds, and calmed the sea. From the castle Saphet a vast panorama, embracing a thousand points of historic and sacred interest, is presented to the eye. Saphet is truly a high tower. Here are beveled stones, as heavy and as ancient in appearance as any ruins in the country, and they prove that this has been a place of importance from a remote age.

Baths and City of Tiberias.—The sea of Galilee is also called the sea of Tiberias, from the celebrated city of that name. About a mile south from the original site of the city, along the shores, are the celebrated warm baths, which the Roman naturalists reckoned as among the greatest known curiosities of the world. The water of these springs has a sulphurous and most disagreeable smell, and is so nauseous that it cannot be drank, and is not used internally. The baths, however, have a great medicinal reputation. There is but one common bathing cistern, where the water is hot enough to cook an egg—from 130° to 140° Fahrenheit—yet it is always crowded with the lame, the halt, the withered, and the leprous.

Nazareth.—Nazareth is situated among the hills which constitute the south ridges of Lebanon, just before they sink into the Plain of Esdraelon. It derives

cubical block of about twenty feet every way, and surmounted by a flattened pyramid of at least ten feet elevation. It is one solid mass hewn out of the mountain, the adjacent rock being cut away, so that it stands entirely detached; there is no known entrance. The tomb of St. James shows a fine front to the west. The cave extends forty or fifty feet back into the mountain. Some two hundred feet north of this is the tomb of Absalom. The entire height of this very striking "pillar" cannot be less than forty feet. Believing it to be Absalom's tomb, the natives throw stones against it, and spit at it as they pass by. Close to this monument, on the northeast, is the reputed tomb of Jehoshaphat.

"The Dead Sea," says Dr. Thomson, "without any reference to what others have said, I can testify to the following facts: The water is perfectly clear and transparent. The taste is bitter and salt, far beyond that of the ocean. It acts upon the tongue and mouth like alum, smarts in the eyes like camphor, produces a burning, pricking sensation, and it stiffens the hair of the head much like pomatum. The water has a much greater specific gravity than the human body, and hence I did not sink lower than to the arms when standing perpendicularly in it. We saw no fish nor living animals in the water, though birds were flying over it unharmed. All of us noticed an unnatural

northern end it receives the stream of the Jordan. The depression of its surface, and the depth which it attains below that surface, combined with the absence of any outlet, render it one of the most remarkable spots on the globe.

THE FORDS OF THE JORDAN.—The reach of the Jordan here shown is the place to which pilgrims of the Greek Church resort every year, in Holy Week, to renew their baptism by bathing in the Jordan, and it is the spot which tradition points out as the place where our Saviour was baptized. The Jordan is a rapid and tortuous stream, interrupted by many rapids, and annually "overflows his banks all the time of harvest." So far as this overflow extends there is a belt of luxurious vegetation, but beyond it the ground is barren.

EGYPT.

From time immemorial Egypt has been an object of interest to the rest of the world. Almost the dawn of Scripture light breaks upon the rocks and sands of this wonderful valley, whose vast river diffuses fertility wherever it flows. Here the children of Israel served the Pharaohs four hundred and thirty years and grew

remains of ancient grandeur that lie to the south, he must engage a Nile boat, which becomes, for the time being, both the means of locomotion and his home; and as all the points of interest are near the river, a more commodious plan for visiting them could hardly be devised. As there are no towns above Cairo everything in the shape of comforts and luxuries must be provided before setting out.

STREET IN CAIRO.—The streets in Cairo, like those of most Oriental towns, are narrow, being some eight or ten feet wide. The houses are mostly three stories in height, each story projecting over the other, and the plain stone walls are either whitewashed or striped with horizontal red bars, as seen in the picture.

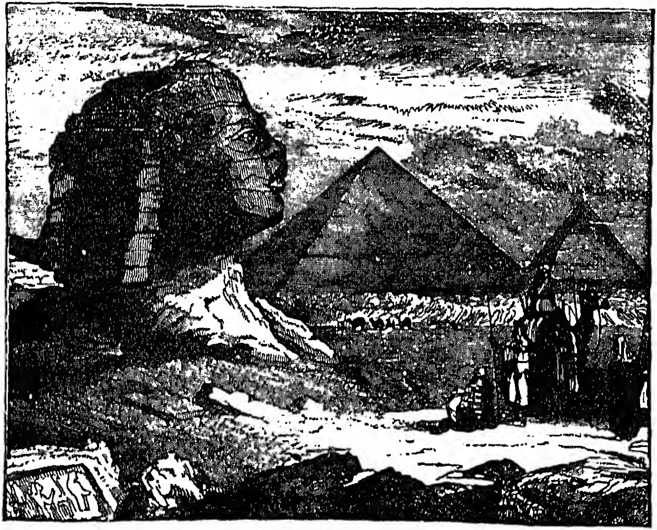
The beautiful latticed windows, "masharobeahs," are the chief ornament of the old Mameluke houses in Cairo. The wood seems rather woven in the loom than cut with the saw and chisel. Through these lattices of fine network, with borders worked in lace-like patterns, and sometimes tipped with slender turrets, the Cairo ladies sit and watch the crowd passing to and fro, themselves unseen. "The mother of Sisera looked out at a window and cried through the lattice, Why is his chariot so long in coming?"—Jud. 5 : 28. Donkey-riding in the streets, and bazars, is almost universal. The animals are small

and free from dust.

Ferry at Old Cairo.—Old Cairo is situated about two miles from modern Cairo. The wonderful clearness and brilliancy of the Eastern atmosphere; the absence of smoke, charcoal alone being burned; the picturesque effect of the ruin into which many of its great monuments are falling; the rich, green valley of the Nile; the river; the Pyramids in the distance; and the fading of the landscape into the boundless haze of the Lybian desert, constitutes a scene which, for splendor and interest, is perhaps unequaled in the world. The taste for gaudy and fantastic coloring has been for ages a distinguishing feature of Eastern embellishment. The alternate red and white stripe is conspicuous on the sails of the ferry boats, which are constantly passing back and forth between Cairo and the island of Rhoda opposite. Here we have a group of Arabs from the desert, with their camels, dealers in oranges, vegetables, sugar-cane, &c. For picturesqueness of costume, there is nothing like the East; the flow of the drapery so simple and natural, the coloring so deep and brilliant.

Tombs of the Memlook Kings at Cairo.—These tombs are fine specimens of Saracenic architecture, and were erected in the thirteenth and fourteenth centuries.

Pyramids.—The Pyramids of Gizeh, three in number,



sides now present the appearance of irregular steps, varying from four feet eight inches to one foot eight inches; but it appears to have been covered originally with a casing of polished granite; a portion of the covering still remains on the second Pyramid. Herodotus tells us that 100,000 men were employed twenty years in building this Pyramid, which appears to have been chiefly intended as a mausoleum of its founder. The granite covering on the second Pyramid makes its ascent

Sphinx. This monument, so imposing in its aspect, even in the mutilated state to which it has been reduced, has always excited the admiration of those who possessed sufficient knowledge of art to appreciate its merits at a first glance. The contemplative turn of the eye, the mild expression of the mouth, and the beautiful disposition of the drapery at the angle of the forehead sufficiently attest the admirable skill of the artist by whom it was executed.

HELIOPOLIS.—Heliopolis, the sacred city, the On, where Joseph's wife, Asenath, lived. A few scattered blocks, a solitary obelisk covered with hieroglyphics, these, with some mounds of sand and rubbish, are all that is left to mark the site of the once priestly city.

THE SIMOOM.—In crossing the desert travelers are frequently exposed to the Simoom or sand storm. Its approach is indicated by a redness in the air, the sky is suddenly overcast, clouds of hot sand obscure everything, and often render further progress for the time impossible. The whole caravan, camels and men, then lie prostrate on the ground till it passes over.

COLOSSAL STATUES OF THEBES.—The Colossi of the plain. These immense sitting figures, fifty-three feet above the plain, which has buried their pedestals, were

adopted in their temples. The entrance by a doorway between two immense moles of stonework, termed pylæ. The victories of Rameses are sculptured on the face of the pylon; but his colossi, solid figures of granite, which sit on either side of the entrance, have been much defaced. The lonely obelisk, seen a little in advance to the left, is more perfect than its mate, which now stands in the Place de la Concorde, at Paris.

Colossal Statue Remeses.—The mutilated statue in this view was the largest monolithic figure transported by the Egyptians from the place where it was quarried. Its weight when entire was nearly nine hundred tons, and this statue now lies in enormous fragments around its pedestal. The statue in its sitting position must have been nearly sixty feet in height, and is the largest in the world; one of its toes is a yard in length. The Turks and Arabs have cut several mill-stones out of its head without any apparent diminution of its size.

Approach to the Temple at Karnak.—From the entrance of the temple at Luxor to the pylon at Karnak, a distance of a mile and a half, an avenue of colossal sphinxes once existed. The sphinxes have disappeared and an Arab road leads over the site. On reaching the vicinity of Karnak the camel path drops into a broad excavated avenue, lined with fragments of sphinxes. As you advance the sphinxes are better preserved and

Hall of Columns at Karnak.—Three thousand years ago and this forest of columns was standing. Here Cambyses stayed his chariot-wheels to gaze in wonder at the triumphs of architecture. Here Sesostris was welcomed back with the loud acclaim of millions from his conquests. The Cæsars were awed into humility when they trod these aisles, and even the Arab hosts, as they swept by on the tide to victory, paused to admire; and the armies of France, as they rushed in pursuit of the flying Memlooks, were so struck with amazement at the ruins that they fell upon their knees in homage and rent the air with their shouts of applause.

The main aisle is composed of an avenue of twelve pillars, six on each side, each thirty-six feet in circumference and nearly eighty in height. Ponderous masses of sculptured stone. The spreading bell of the lotus blossoms crown them with an atmosphere of lightness and grace. On each side of the main aisle are seven other rows of columns, one hundred and twenty-two in all, of immense size, and so close as sometimes not to allow a column that has lost its erect position to fall to the ground. They date from the time of Rameses III, the Sesostris of Greek writers. These columns are a good illustration of the way in which the Egyptians covered all parts of their buildings with inscriptions.

part of the Hall of Columns.

THE APPROACH TO PHILÆ.—Philæ, the "Jewel of the Nile," is situated a short distance from those rapids of the Nile, known as the first cataracts. These cataracts are formed by the bed of the river being crossed by a formation of granite, through which it has cut its way, producing a series of rapids. Opposite to these cataracts stood the ancient city of Syene. It was from the quarries at Syene that the Egyptians obtained their monoliths, whether obelisks or statues. These were sculptured on the spot, and then transported by the labor of men to the places where they were to be erected. The island of Philæ contains about fifty acres, and is covered with ruins of temples and palaces, all of which belong to the Ptolemaic period. The basin of black jagged mountains folding it in on all sides, yet half disclosing the avenues to Nubia and Egypt; the clusters of palms, with here and there a pillar or wall of a temple, the ring of the bright river, no longer turbid, as in lower Egypt; of these it is the centre, as it was once the focus of their beauty.

VIEW ON THE ISLAND OF PHILÆ.—The temple which belongs to the era of the Ptolemys, and is little more than two thousand years old, was built by various monarchs, and is very irregular in its plan. The columns of

is derived from a tradition that Osiris was buried at Philæ, and from this it was that the Egyptians were in the habit of swearing by him who lies at Philæ.

SCULPTURED GATEWAY.—This is a good illustration of the way in which almost all parts of the buildings were covered with inscriptions. The large figures on this doorway were originally painted in bright colors, and on some of these, patches of the original paint still remain.

TEMPLE EDFOU.—This is perhaps the best specimen extant of the pylon of the Egyptian temples; it is upwards of one hundred feet in height, but a considerable part of the base is covered up with sand, which has also almost filled up the area of the temple. In this part the valley of the Nile is wider than in many places; it varies from about ten miles in width to only enough to allow of the passage of the river. Many of the temples are built close to the waters of the sacred river.

TEMPLE OF KALABSHE, NUBIA.—The space inclosed within the ruins of this temple is covered with sculptured figures, among which the most remarkable is the representation of a human sacrifice, where the victim, whose whole clothing consists of a scanty waist-cloth, is on his knees with his hands tied behind his back.

he brandishes a small axe, ready to strike off his head. This horrid scene takes place in the presence of Osiris Hierax, who is seated on his throne enjoying the spectacle.

THE SHADOOF.—This view presents a scene on the Nile. A group of stately palm trees, tall and slender, with feathery plumes on their proud heads, and large clusters of golden fruit. The shadoof is a simple contrivance for raising water; a method very common both in ancient and modern Egypt. It consists of a lever moving on a pivot, which is loaded at one end with a lump of clay, or some other weight, and has at the other a bowl or basket, as seen in the picture. Wells have usually troughs of wood or stone, into which the water is emptied for the use of persons or animals coming to the well.

VIEWS OF INTEREST IN DIFFERENT PARTS OF THE WORLD.

These are described in gazetteers, and to some extent in school geographies. Some lecturers appear as very accomplished travellers by using well-written guide-books.

For an acquaintance with historical pictures, we may consult the histories of the times.

With regard to "views conveying moral lessons," the name of each slide affords a text upon which the lecturer may base what remarks he may have to offer.

At the risk, however, of making the rest of our matter seem prosy by contrast, we will copy just the closing part of the description of a long slide of animals, to indicate how much is made to depend on words and music, and how little on the merits of the slide.

[*Sound of Horn. Music. Last tune of the* "LANCERS."]

Yes, here we are in full cry! The real thing, too!!

"Old Mother Slipper Slopper jumped out of bed,
And out of the window she poked her head;
Husband! O husband! the gray goose is dead,
And the fox is gone out of the town, O!"

Yes, there he goes, and the old lady after him, and she has called up John, the servant, and he joins in the chase, and old Mr. Slipper Slopper comes next; but he's rather behind, as he's been to call "Bumble," the parish constable, who has come out with his staff to catch the thief. Tally ho!

And now, my children, recollect I told you that the lion was the king of the beasts, and so, as a conclusion to this entertainment, I shall show you how he kept his court. (*Music.*)

There he is, sitting in full state; and now, if our kind friend at the piano will play a "March," you shall see a grand procession, and all the animals passing in order

The miscellaneous views in Class X are mostly composition pictures, suggesting their own descriptions. Take, for example, this picture of the milkmaid.

The cow, so gently submitting to the maiden's manipulations, evidently feels quite at home. Appearances indicate that she is capable of giving a pailful of milk. She has taken the position convenient for the milkmaid, who, for the time, has suspended operations for a social chat with the young farmer who is resting upon the barnyard gate. We may not hear what they say, but little sister, doubtless, is verifying the old adage, that "little pitchers have large ears."

The two reclining animals may have borne the yoke seen at the left, during working hours, and are now wooing

that admiring young farmer and the loving maiden. May the course of their true love ever run smooth.

STATUARY.

Statuary and many other pictures may also be announced, and then described by what the picture itself shows, as in the example following:

THE COUNCIL OF WAR, by John Rodgers.—President Lincoln is seated and holding before him a map of the campaign. Secretary Stanton stands behind his chair, wiping his glasses and listening to General Grant, who is explaining his plan, which he is pointing out on the map.

THE SEASONS, by Thorwaldsen.—Four circular bas-reliefs, viz.:

Spring.—A female figure, attended by two genii bearing baskets of flowers.

Summer.—A harvest scene, with a group of reapers.

Autumn.—A hunter returns to his home bearing game; a woman and child (seated beneath a grape vine) receive him.

Winter.—An old man warming his hands over a brazier, while an old woman lights her lamp.

"Behold, fond man!
See here thy pictured life; pass some few years,

MOVABLE SLIDES.

These of course tell their own story. Now and then, an appropriate recitation can be found for them.

The swan floating upon the moving waters, for instance, may be assumed as illustrating the legend that her first and only song is sung as she floats down the river on her dying day.

> " 'Tis the swan, my love,
> She is floating down from her native grove,
> No loved one now—no nestling nigh—
> She is floating down by herself to die.
> Death darkens her eye and unplumes her wings,
> Yet the sweetest song is the last she sings.
> Live so, my love, that when Death shall come,
> Swan-like and sweet, it may waft thee home."

Spectators, in the limited time given them, can hardly be expected to take in all the details of a complex view, without more or less of this particularizing, which can be resorted to as occasion requires, therefore, in connection with a wide range of subjects.

SCIENTIFIC SLIDES, &c.

The illustrations enumerated in the Scientific Department, of the appended catalogue, are suited to the text-

immemorial been accompanied by a printed lecture, which, though somewhat antiquated, still answers a pretty good purpose.

Could a suitable lecture of similar shape accompany each of the forty sets of scientific illustrations, it would prove advantageous to many, and it would do no harm to any; so we are looking for something of the sort in the near future. But these sets of scientific slides themselves leave scarcely anything to be desired in the way of fitness and excellence; and we have, moreover, in the Sciopticon an instrument unrivaled for convenience combined with efficiency.

As before intimated, little has been attempted in this chapter but to indicate some of the ways of finding descriptions.

When the use of the magic lantern was very limited, its slides could be described in small compass; but now, a work that should describe all the slides in use, would hardly be less voluminous than the Encyclopedia Britannica.

DESCRIPTION OF THE SCIOPTICON.

[*From the Journal of the Franklin Institute.*]

"Our attention was drawn some time since to this very decided improvement in lanterns illuminated by ordinary flames, by which their efficiency is so greatly increased that many results can be reached which were heretofore only attainable by aid of the lime or magnesium lights.

"The most important feature in this apparatus is the lamp, or, as it might, in this case, be called, from its appearance, the furnace. This source of action to the entire machine is placed in a cylindrical chamber, provided with a chimney, and has two flat wicks, one and a half inches long, parallel to each other and to the axis of the chamber, and in fact the optical axis of the instrument. The flames, or rather sheets of flame, that rise from these wicks are drawn together by the arrangement of the draft, and so form a pointed ridge or edge of intense light in the axis of the condensers. We have, on various occasions, alluded to the fact long ago pointed out by Rumfort, that flame was practically transparent. Here this property is utilized, and by reason of it we can get through the condenser all the accumulated brightness of the long line of light, one and a half inches deep.

"There are many details of construction which are of very ingenious and efficient character, among which we would specially notice the slide for pictures, by which, one picture being in use, another may be removed and exchanged, and then, by a single movement, brought into the field, while the other is in like manner ready for substitution."

THE MAGIC LANTERN FROM 1650 TO 1870.

[*From the Scientific American.*]

"The invention of the Magic Lantern dates back to 1650, and is attributed to Professor Kircher, a German philosopher of rare talents and extensive reputation. The instrument is simple and familiar. It is a form of the microscope. The shadows cast by the object are, by means of lenses, focused upon something capable of reflection, such as a wall or screen. No essential changes in the principles of construction have been made since the time of Kircher; but the modern improvements in lenses, lights, and pictures have raised the character of the instrument from that of a mere toy to an apparatus of the highest utility. By its employment the most wonderful forms of creation, invisible, perhaps, to the eye, are not only revealed, but reproduced in gigantic proportions, with all the marvelous truth of nature itself.

tive qualities of beauty, amusement, and instruction.

"The electric light affords probably the strongest and best illumination for the Magic Lantern; then comes the magnesium light; but their use is a little troublesome and rather expensive; next to these in illuminating power is the oxy-hydrogen or Drummond light. The preparation of the gases and the use of the calcium points involve considerable skill.

"Need has long been felt for some form of the Magic Lantern having a strong light, but more easily produced than any of those just mentioned; and this has at last been accomplished, after several years' study and experiment, by Professor L. J. Marcy.

"The Sciopticon is the name of his new instrument, and from actual trial we find that it possesses many superior qualities. Its lenses are excellent, and in illuminating power its light ranks next to the oxy-hydrogen. The Sciopticon light is produced from ordinary coal oil, by an ingenious arrangement of double flames, intensifying the heat and resulting in a pencil of strong white light. Professor Marcy's instrument is the perfection of convenience, simplicity, and safety. Any one may successfully work it, and produce the most brilliant pictures upon the screen. It is peculiarly adapted for school purposes and home entertainment. Those who wish to do a good thing for young people should provide one of these instruments. Photographic transparencies

TRAVELLING BY MAGIC.

BY EDWARD L. WILSON.

Editor of the Philadelphia Photographer, and Photographic World.

Marcy's Sciopticon is what we want to give us a view of the world at large, while seated in our own drawing-room, enjoying all the comforts of home, and the pleasures of social intercourse.

Give us the Sciopticon, with the necessary slides, before a screen or a white wall, and we will carry you as fast or as slow as you wish, wherever the foot of man has trod, in excellent and comfortable style.

First we look upon the screen and, in imagination, we go driving along over the Union Pacific Railroad. We visit the large cities on our way, and get as good ideas of their grain elevators and their churches as if we stood by their side. We see the Mormon tabernacle, and capture Brigham in person for our screen. On we go, over the prairies, amid the buffaloes, dodging under the great snow-sheds, climbing up the inclines of the jagged Sierras, and lo! (not "the poor Indian") we stand watching the gambols of the seals in San Francisco Bay, straining our eyes to reach the summit of El Capitan in the Yosemite Valley, listening to the rustlings of the Bridal Veil, or clambering up the sides of "General Grant" in the Mariposa Grove.

boulder in the flume, all in one half hour.

Then, after we have seen Niagara from a hundred standpoints, views made in winter and summer, and travelled up the Mississippi, through Watkin's Glen, inhaled the freshness of White Sulphur Springs, wandered among the wildernesses of North Carolina, and seen Florida and Cuba, not to forget the Mammoth Cave, we may go over to Europe. There we ascend the Alps with Prof. Tyndall, go down into the caverns, and clamber among the icicles, or traverse the awful glaciers with their yawning, ever-hungry crevices.

Or we may see in the same way the ruins of India, the mysteries of Pompeii, the tombs and pyramids of Egypt, or Rome's seven hills covered with glories, to say nothing of humiliated Paris or exultant Germany.

Everything that photography can produce may be served up in excellent style, and with little trouble through the instrumentality of Marcy's Improved Magic Lantern. Last evening I had the pleasure of entertaining and delighting a whole company of men, women, and children for an hour or two in this way, at the extreme cost of five cents for coal oil!

The great efficiency of the Sciopticon, as compared with any other lamp-illuminated lantern, together with its simplicity, symmetry, and compactness, its safety, convenience, and fitness for slides of every variety and

SCIOPTICON FOR SUNDAY-SCHOOLS.

BY E. D. JONES, ESQ.,

President Missouri State Sunday-School Association.

"While the great aim of all Sunday-school effort is to teach the word of God, seek the conversion of scholars, and train such in the ways of holy living, yet there are appliances and helps that may be used to attract and interest young minds where they do not in any way conflict with the grand object of the school.

"It is a religious institution, and its interests should be well guarded from all that would in any way lower the dignity of its mission. Some time since I introduced the Sciopticon, a recent improvement in the line of the Magic Lanterns, of which Prof. L. J. Marcy, of Philadelphia, is the patentee.

"I found the instrument wonderfully simple in construction and management. Its lamp burns simple coal oil and gives a most intense light, and in the production of pictures on the wall or on the screen equals any of the most expensive Magic Lanterns, with calcium lights, that cost so much labor and expense."

SCIENCE AT HOME.

(Communication from the President of Franklin Institute.)

MR. L. J. MARCY.

DEAR SIR: During the winter of 1872–73 I was in-

readily performed with the Sciopticon. My good friend, Prof. Henry Morton, of the Stevens Institute of Technology, in Hoboken, has already described many of these experiments in your manual. I have told you how I have repeated many of them with very little expense in the way of apparatus, and I would now suggest to the would-be purchasers of your lanterns, that should they desire to use it as an adjunct to the lecture table, they need not be alarmed at the expenditure needed to procure all the fixtures required to perfect it. One of the chief pleasures in its use is in the improvising of what is needed. Those who have long purses may prefer to purchase all needed pieces of apparatus, ready-made to their hand, but a few hints may serve to show how they can, with very little skill, prepare what will answer their purpose. As an illustration, let me recall the very pretty experiment usually called the broken arrow, which is shown to illustrate refraction. As an object in the lantern, a brass plate having an arrow-shaped opening in it (procurable at the instrument makers) is put in place, this throws upon the screen a white arrow on a dark ground; now, if in front of the brass plate a strip of thick glass, narrower than the length of the arrow, be held parallel with its surface, no distortion of the arrow image will be seen; but if the glass be inclined so that the rays of light pass through it obliquely, a piece of the arrow will seem to be cut out and be moved to one

paste on damp walls before papering, and some paste made of gum tragacanth; with a sharp knife, laying the foil on a plate of glass, the arrow-shaped opening can be readily cut, and its edges will be as smooth as the most skilful mechanic can make a brass plate. This foil, so prepared, should be mounted between two slips of glass, and the edges bound with paper. Gum tragacanth will cause paper to adhere to glass very firmly and is a nice, clean paste to use. The slide thus prepared will be found to be quite as good as the most costly one procurable in the stores. In my own experiments, when I require slits or openings of any required shape, in opaque plates, I have invariably made them in this manner, with a feeling of satisfaction at their cheapness.

A very convenient device to show wave motion can be made with this tin foil. One slide is made with plates of glass, 3 x 4 inches, having tin foil inclosed, in which slits are cut crossways, say $\frac{1}{16}$ inch wide, 2 inches long, and the slits placed $\frac{1}{8}$ of an inch apart. I have sometimes pasted slips of tin foil $\frac{1}{8}$ of an inch across the plate, at equal distances, say $\frac{1}{16}$ of an inch, in preference to cutting them in a solid piece of foil. This slide will show vertical bars of light on the screen. If now another slide be made of two glasses, 3 x 6 inches, with foil between them, in which foil a wave-like opening be cut, say $\frac{1}{8}$ of an inch wide, this slide of itself would show in the lantern a wave

India-ink admirably, and diagrams can be traced, or pictures copied in a rough way, by laying the glass plate so prepared over the picture to be copied and tracing its outline with a pen filled with good India-ink.

I would strongly advise any one using your lantern to procure some of the comic slides, such as you illustrate in Class XV of your catalogue of slides, and they can see how to make similar ones to be used in illustrations of scientific subjects. Thus with the wreck of one of these three glass slides, picked up at some opticians and purchased for a few cents, I improvised a slide which answered better to illustrate the process of carbon printing in photography than the process itself would have done in a lecture-room. One figure changed with another by means of sliding glass plates is very useful in many kinds of experiments or illustrations of facts and processes.

The tank figured in your manual, in Chapter VII, on Chemical Experiments, contributed by Prof. Morton, can be made to do service in a long line of experiments with electricity, by a very simple device. Thus, to illustrate the decomposition of water, cut a slip of segar-box wood, of a size that will lay on the bottom of the tank loosely, attach to this bit of wood copper wires, which will extend up to the end of the tank and will not quite meet at the centre of the bit of wood; to upturned ends

prevent the wood from absorbing any moisture. This little frame placed in the tank, immersed in acidulated water (water with a few drops of sulphuric acid), and the terminal wires attached to say two cells of Groves' battery, will show the decomposition of water admirably. A similar piece of apparatus with the terminal wires at the centre of the board, united by a vertical coil of very fine platina wire, will be found useful in illustrations of circulation by heat. Such a frame immersed in clear water will be seen on the screen as a black coil, seemingly hanging down from a black bar on the top of the screen; if now, by means of a pipette, some colored fluid, say a solution of permanganate of potash in water, be carried to the bottom of the tank, it will on the screen seem to spread itself out as a red stripe under the black one and enveloping the little coil; a current of electricity passed through the wire will heat the little platina coil and thus heat the water in contact with it, so that currents will be established in the fluid, carrying with them the colored fluid in a very beautiful curling cloud of color.

I mention to you these few examples, of how readily the needful appliances for illustrations can be improvised; now I have frequently heard persons say that they "feared the expense entailed in the use of a lantern" that "the lantern is so useless without a great many

A PROCESS FOR DRAWING AND PAINTING MAGIC LANTERN SLIDES.

The following process is given to assist persons who own a Sciopticon, to prepare for themselves a portion, at least, of the necessary transparencies, especially educational illustrations. It has been our aim to simplify the whole matter as much as possible consistently with giving such directions as are safe and practicable. It is true that there are some other colors and materials which can be used, but the list given below contains *all* that are *necessary* for the production of hand-made pictures, or for coloring photographs on glass in this style.

LIST OF APPARATUS AND MATERIALS.

Easel,
Glass slab,
Palette-knife,
Sable pencils,
Duster,
Point for erasing,
Hard black-lead pencil,
Fine pen,
Varnish, Nos. 1 and 2,
Liq. India ink,
Canada balsam,
Siccatif,
Tube of blue-black in oil,
Tube of crimson lake in oil,
Tube of Italian pink in oil,
Tube of Prussian blue in oil,
Tube of burnt sienna in oil,
Ol. Turpentine,
Glass,
Mats,
Binding-paper,
Box for the above articles.

For amateur work we very decidedly recommend that the pictures should be made on the 1-4 size of glass known to photographic stockdealers as "B. P. C."

After the painting is finished and dry, it is only nec-

gers must not touch the surface of the glass after it is cleaned.

The next step is to prepare the surface of the glass for the drawing. If the glass (as is usual with this kind) is slightly curved, the *concave* side should invariably be the surface to receive the preparation. This preparation is as follows: "The plate to be dusted and gently warmed; then flow the surface with No. 1 varnish, and drain into the bottle from the corner of the glass. When this is dry, flow with No. 2 in the same manner, and afterwards dry with gentle heat. Of course until the varnish is dry the corner from which the varnish was drained should be kept down. Should dust find its way into the varnish, it can be filtered." Having prepared the surface, it should not be soiled by handling (always take the glass by the edge between the fingers). A sketch can now be made on the surface with a good hard *black*-lead pencil, either as an original drawing, with the glass on the easel, or by placing the glass on an engraving or other picture, and tracing the outline.

When this sketch or outline is finished, strong and black lines and marks can be made with the "liquid India-ink" in a fine pen, gently used so as not to make the lines too coarse and heavy. With the pen, too, lines can be ruled or letters or figures added. After the drawing is finished and dry, any little corrections or scratches can be made with the pointed eraser.

from extra light which comes from above the easel.

Although the pigments in our list are so few in number, yet with these, by proper admixture, *all* the colors can be made.

To mix these colors for painting we will suppose we take from one of the tubes a quantity of color of the size of a small pea, to which we add about half as much Canada balsam, and one or two drops of siccatif. The use of the balsam is to make the colors *transparent;* the siccatif is simply a *drier*, and of this last we should always use as little as is consistent with the colors drying in a reasonable time.

If a picture involving a variety of colors is to be painted, it is best before commencing the work to prepare not only the simple colors in the tubes, but also some of the most important mixtures, as follows:

Greens.—Prussian blue and Italian pink. (To make a dull green, use some burnt sienna with the above.)

Orange and Flesh-tints.—Italian pink and crimson lake. For some shades add burnt sienna.

Browns.—Italian pink, Prussian blue, crimson lake, and burnt sienna.

Any shade of brown or neutral tint can be made by the use of these pigments in various proportions, which can only be learned by experiment.

Having prepared the colors on the glass slab (mixing well with the palette-knife), and the drawing being all

strokes. We don't mind about trees, spires, &c., we can take the sky tint off from them where we wish to do so afterwards (before the color is dry) with a sable brush, *slightly* moistened with ol. turpentine, but the brush must not contain enough to *spread at all* on the surface, otherwise the color will flow away from the line we wish to establish, and form a ridge on the sky.

A better way to apply sky tints is to stipple or daub the surface with a little paint on the end of the finger. In this way all the finest skies are painted by the best artists who make pictures for the magic lantern, but the process is one that can only be learned by many trials and much practice.

After the sky is painted and removed from places where it is not wanted, distant hills next receive our attention, successively working upon objects nearer and nearer, until the whole picture has received its first painting. Except for skies the colors will not need thinning with ol. turpentine.

The picture should now be put out of the way of dust and sunshine, and where it will dry. The next day such parts as need can be repainted, and, if necessary, any successive number of coats can be applied, allowing a day between each for the paint to dry. When completed, it only remains to put on a mat and cover and fasten the edges with paper strips. *Flour paste* (too stiff to allow moisture to be drawn up between the plates)

parently insuperable difficulties.

It may be proper here to state that we now furnish a varnish to take the place of No. 1 and No. 2, which answers equally well with but once flowing. Like No. 2 it must be dried by heat to prevent what is called "chilling." The operation can be best performed in a dry atmosphere which is free from dust.

A Copying Camera.—A private letter from Prof. W. A. Boles, of Shelbyville, Ind., Superintendent of Schools, contains further valuable information in this direction, and a description of a new instrument of his own invention. By permission the following extracts are given in the interest of home production.

"With this mail I send you a specimen of my drawing on gelatine-coated glass, for use in the Sciopticon. After the coating of gelatine is perfectly dry, I sand-paper it with the finest article I can get, and after the picture is drawn, float it with your No. 1 varnish. . . .

"I made an upright camera-obscura, using the lens from the Sciopticon. The picture to be copied is placed beneath, in the sunlight if possible, and the image is thrown upward so that I can trace the outlines quite at my ease. On the roughened gelatine a fine steel pen and the ordinary black ink I am now using mark beautifully, and the shading is done with a lead pencil. By tracing the image of the picture, in the little darkened

connected by two iron braces and slide up and down, for the desired focal distance, above the lens *C*. The adjustable shelf *D* supports the object to be copied. The glass plate is laid upon the rest *B* over the opening, and a black cloth thrown over the top. The instrument is six feet in height, and eighteen inches square, and cost me about two days' labor. It is highly satisfactory."

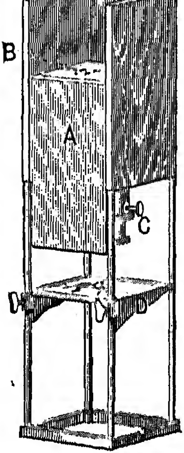


Fig. 31.

It will be understood that the object of roughing the gelatine, as indicated in the above letter, is that it may present an opaque surface to render the image visible, like the focusing ground-glass in a photographer's camera; this roughing also gives it a "tooth" to hold the markings.

Ground-glass itself is sometimes used for obtaining drawings by superposition, which is rendered transparent by a coat of varnish, and it might be used in this case; it is, however, somewhat expensive. A surface is now produced on glass quite similar by what is called the ground-glass varnish. This surface after receiving the drawing may also be rendered transparent by a coat of common varnish, if dried in sufficient heat to prevent

superposition.

This process, obtained by purchase, is given for the benefit of teachers, who will find it admirably suited for maps, diagrams, and any so-called blackboard exercises.

Ordinary Transfers upon Glass.—Coat, by preference, quarter-plate B. P. C. glass on the hollow side with transfer varnish, and let it partially dry. Take any cut of proper size, place it upon water right side up until it becomes wet to saturation, adjust it to the varnished surface face down, rub up the paper in rolls until it is mostly removed, and then lay it aside until the varnish becomes hard. Much of the remaining paper can now be removed without damaging the picture, by carefully wetting and rubbing.

Grecian varnish will render the picture transparent; but unfortunately innumerable pimples make their appearance, which show badly on the screen, caused by the loosened fibres of the remaining paper film. Several coats of varnish will finally leave a smooth surface, but so thick a coating will before long crack and eventually peel off.

This process is here referred to because it is so often inquired about, rather than because it is thought to be of much value.

Diaphanie.—A picture on thin, smooth paper, treated as above, but without rubbing off any of the back

DECALCOMANIA, OR ENAMEL SLIDES.—Impressions made on starched paper and fixed to glass, as above described, will adhere to the varnish when the paper is afterwards wet and pulled off entire. After soaking off the starch, by flowing water and a soft brush, the picture is dried and flowed with ordinary slide varnish. These so-called Enamel Slides are inferior to silver prints, and are sold, both plain and colored, at a cheaper rate.

Should the paper prints, in good variety, eventually be sold to the public, full directions for transferring them would doubtless also be supplied. On this supposition only, would this truly interesting process promise to become available for amateurs.

TYPE PRINTING upon glass, except in a poor way with elastic type, is impracticable. Hymns, mottoes, &c., may, however, be printed to advantage upon sheet gelatine, in the small amateur printing-presses now so much in vogue. Plain collodion films, dried upon oiled glass, upon a levelling stand, and peeled off, will take impressions perfectly. These films may be mounted between glass plates, in the form of a crystal slide.

WITH QUARTER-PLATE GLASS prepared as described to receive, like paper, not only colors but pen and pencil drawings, we may copy engravings for the lantern by superposition, or in a camera similar to the one illustrated by Fig. 31, may show up, as by magic, all that

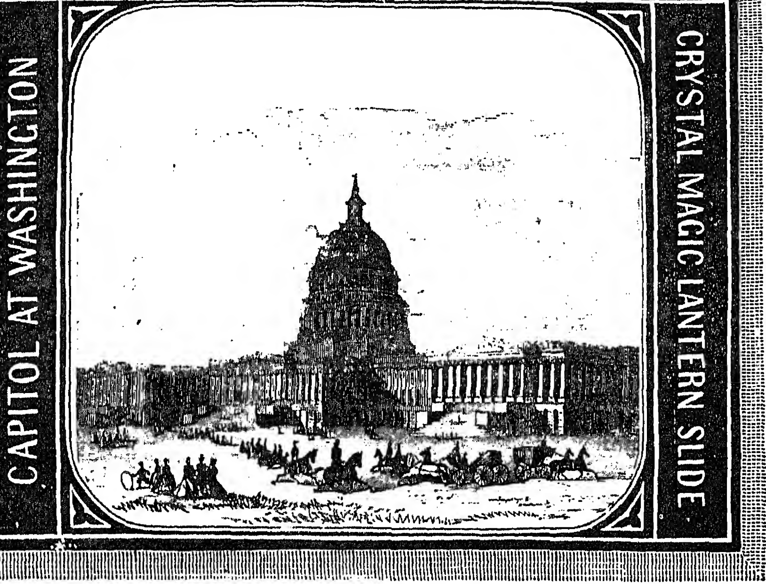


Fig. 32.

The cut (Fig. 32) shows the exact size and shape of the transparency, mat, glass, and the binding of the Woodbury (photo-relief) magic lantern slide, of the colored crystal slide, and of such as are made according to the directions given in this chapter.

Pen and pencil drawings would require only Nos. 7, 8, 9, 10, 19, 20, and 21 of the materials enumerated on

CHAPTER XI.

NOVELTIES.

THE CHIMNEY CAP of the Sciopticon now telescopes into its base, so as to give added length and greater draft when drawn up. It should not be elongated, however, when the instrument is first lighted—especially if the wicks are not well saturated with oil—but when well under way, the added length, with a corresponding turning up of the wicks, gives greater brightness, and more effectually draws off the heat.

THE SCIOPTICON CURTAIN.—Turning the milled head at either side, gives the appearance upon the screen of a curtain rising, or falling, thus handsomely opening or closing an exhibition. It may also be temporarily closed at any time, to allow the attention to be directed to other exercises.

The process of changing the pictures may be hidden from view by shutting off the light with the left hand; then pushing the out-going picture into the left hand by sliding another into its place with the right; and then flashing on the light with the right hand; all of which may be sooner done than said. In any change of programme the awkwardness of showing the "full moon."

the curtain, but with a gradual shading. With the blue tint partially drawn, this property gives to plain photographs of scenery, a blue sky, shading off without abruptness down to the horizon. Slightly drawing up the blue, then the red, and then turning the button attached to the opaque curtain a little, fades away gradually the upper portion of the disk, as is desirable in such slides as the Ascension. The reverse movements bring into view gradually the "Soldier's Dream," "Angel of Peace," &c., nearly as well as with two slides in the dissolving lanterns. All the appearances formerly produced by colored glass slides are better effected by these tinters. If at any time the rods become too loose, the *stop* screws may be tightened.

The New Slide Stop.—The catch drawn out from the underside of the stage, and turned back almost out of the way, is intended to stop the slide in its proper position, but not to interfere with its being moved smoothly along and out by the incoming slide when slipped forward from the catch by the left hand.

The catch pushed back into its sheath, leaves the stage entirely unobstructed for those who prefer to adjust the slides by hand only, and for other than wooden slides.

The use of stops is the more necessary with a pair of

into use larger and clearer views.

A magic lantern picture of the standard size is 3 inches in diameter, mounted in a frame 7 inches long by 4 inches wide. The new picture is 3½ inches in the clear, in a frame 7 inches by 4¼ inches.

The new picture having a third more surface, the illuminated disk shows larger in proportion and to very much better advantage. No one seeing an exhibition of the new slides, would willingly select from the old.

No inconvenience arises from using both kinds in the same exhibition. The larger frame, reaching a little higher than where the spring meets the condenser, slides more smoothly into place.

Great pains has been taken to get the best subjects with which to inaugurate this new departure, and to have them worked up in the most artistic style.

Marcy's Eidotrope.—Two disks of perforated tin are mounted so that one extends beyond the frame to the right, and the other to the left; and so, not having a common centre, an eccentric revolution is given to each, little by little, when moved by the fingers at either side of the lantern, producing upon the screen a great variety of strikingly beautiful patterns, which may be pleasingly modified by a varying use of the tinters. Its simplicity, however, may be against it, for *effects* are quite apt to be valued in proportion to their cost and trouble.

ent disk, covered with figures in varied positions, is revolved with less rapidity in the opposite direction.

Our improvement consists in having the distance of the crank wheel adjustable, and in having only one band doubled back to run both wheels, so that the tension of the band can be regulated, while both effect wheels are subject to a band of like tension.

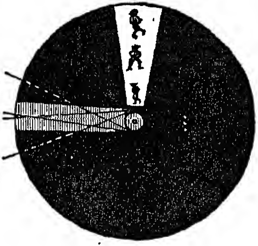


Fig. 33.

Four adjustable disks of figures, viz.: the Fishers, the Skaters, the Giant's Ladder, and the Bottle Imp, are now included in this new apparatus; each, when used, being held in place by a wire ring sprung into a surrounding groove.

The Dancing Skeleton.—This effect is produced by having, say six transparencies of a skeleton, in as many different postures, set in a large disk, as shown in Fig. 34. Giving this wheel $\frac{1}{6}$ of a revolution at a time, brings the figures one by one into position to be projected upon the screen, while a revolving opaque disk hides the passing off of one, and the coming on of another, making it appear as if the same figure

Fig. 34.

sale at $30.

THE DANCE OF THE WITCHES.—Paper witches are put into the cell (Fig. 35) and the picture of a cauldron is drawn upon its outer face. This cell is filled with water, which, with the floating witches, is made to circulate about the pot by means of pipettes with rubber bulbs, reminding us of the scene in Macbeth :—

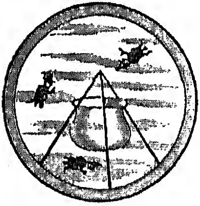


Fig. 35.

"Roundabout the cauldron go;
In the poisoned entrails throw,—
Double, double, toil and trouble,
Fire burn, and cauldron bubble."

THE BEEHIVE.—Upon the fixed glass, a beehive and shrubbery are artistically drawn and colored. Two disks of glass covered thickly with figures of bees on the wing are revolved in opposite directions, presenting upon the screen a very lively appearance.

THE AQUARIUM.—Upon the fixed glass, an aquarium with dark background is drawn, while fish are made to appear as swimming back and forth, passing and repassing each other, by revolving in opposite directions, the disks upon which they are painted.

THE FOUNTAIN.—The appearance of a fountain in full

The following four pairs of effect slides for the double lantern, with sliding movements (price $6 a pair), are quite popular at present, but they are difficult to operate satisfactorily.

THE NAIAD QUEEN.—View of a lake by moonlight. The moon glistens on the water; a castle is seen in the distance. The Naiad Queen appears sailing across the lake in a pearl shell boat and playing on a harp. (Music can be used very effectively with this view.) Two slides, with movement.

TRAIN OF CARS.—A railroad bridge in a dark forest is seen by moonlight. A train of cars dashes by, the head-light, and sparks flying from the engine, making a very brilliant appearance. Two slides, with movement.

OCEAN STEAMER.—A view of a harbor is represented, with a city in the distance, from which an ocean steam-ship, bound for Europe, sails away. Two slides, with movement.

THE SERENADE.—A beautiful view by moonlight of a lake, on the borders of which is seen a castle brilliantly illuminated. The serenader appears sailing in a gondola and playing a guitar. A lady steps out upon the balcony of the castle and listens to the serenade. (Music can be used in connection with this effect.) Two slides, with

The vision of Columbia, attended by Justice and Plenty, appears in the sky.

The Soldier's Dream.—This is best told in Campbell's Poem, beginning:

> "Our bugles sang truce, for the night cloud had lowered,
>   And the sentinel stars set their watch in the sky;
> And thousands had sunk on the ground overpowered,
>   The weary to sleep and the wounded to die.
> When reposing that night on my pallet of straw,
>   By the wolf-scaring faggot that guarded the slain,
> At the dead of the night a sweet vision I saw,
>   And thrice ere the morning I dreamt it again."

Mercy's Dream.—Mercy is represented in a reclining position beneath a spreading tree. An angel from Heaven appears and places a crown of glory on her head.

Angel of Peace.—A beautiful landscape showing a city at night, with the new moon in the sky reflected in the water. The figure of an angel bearing a child appears like a vision in the sky, and then fades away.

The Fairy Grotto.—A view looking out from a grotto into a lake, upon the surface of which are interspersed rocks and trees in a picturesque manner. A fairy with wand is seen in the foreground. The moon appears from behind the clouds and its reflection is seen on the rippling waters.

The Lime Light.

INTRODUCTION.

The Lime Light in an improved form having been introduced into the Sciopticon, it becomes expedient to append to the Sciopticon Manual a description of the apparatus and directions for its use.

FLAME ILLUMINATION.

We have in the Sciopticon oil lamp arrangement the largest amount of ordinary flame illumination that can, to advantage, be brought to bear upon the screen through the objective lens, and as bright as air with its twenty per cent. of oxygen will make it.

Brightening the two flames by an inner supply of oxygen gas, after the manner of the Bude light, heats the wick tubes to an unsafe degree, and consumes too much oxygen as compared with the efficiency of the illumination.

Some solid matter, of which quick-lime seems to be the best and cheapest for the purpose, is more luminous in an intense heat, than simply the particles of burning carbon floating off in flame.

VARIETIES IN LIME LIGHT.

the lime from reservoirs under equal pressure, and through a common jet.

In absence of well established and distinctive terms, we seem obliged to fall back upon the only elementary distinctions, as alcohol, house gas, and mixed jet; or simply Nos. 1, 2, and 3.

THE ALCOHOL BURNER.

The lime light produced by a jet of oxygen gas through an alcohol flame, as now used with improved effect in the Sciopticon, is suited, next to the Sciopticon oil lamp, to the widest range of circumstances.

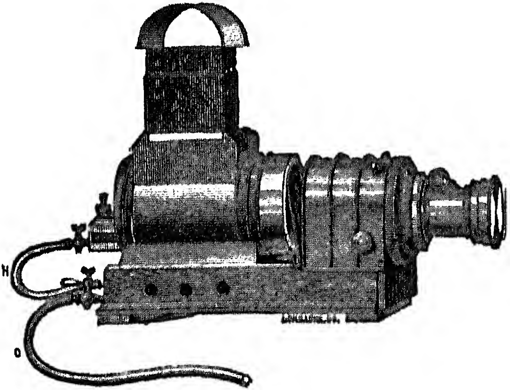
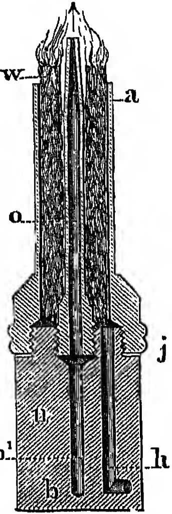


Fig. 36.

gon bag, or cylinder, which is not here shown.

The alcohol passes through a side aperture, *h*, up the nozzle *n* (Fig. 37), to its level in the cylindrical wick-tube *a*, filling it about two-thirds full, and saturating the wick *w*, which loosely fills the space between the concentric tubes.



No. 1, Fig. 37.

If on lighting the wick (which is done by reaching it in the lantern with a lighted match) it burns feebly, for want of being fully saturated, we may give the flexible alcohol tubing, *H* (Fig. 36), a sliding pressure towards the jet, being careful not to overflow the wick tube. The alcohol should be of the best quality, and high enough in the fountain to feed a vigorous flame.

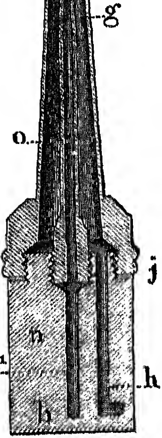
The atmosphere, while supplying oxygen to the outside of the flame, compresses the inner hydrogen vapor into combination with the jet of oxygen as it strikes upon the lime above.

When the exhibition is over, we may let the fountain hang down by its tubing till the alcohol drains back into it, before closing the stop-cock.

THE HOUSE GAS BURNER.

In towns and wherever illuminating gas is in supply

middle arrow from the *fan-mouthed* jet, *o* (see its shape, front view, Fig. 39), combines with the hydrogen instantaneously as it strikes the lime, with little tendency to cool and blacken a central spot.



No. 2, Fig. 38.

THE DRUMMOND LIGHT.

Lime rendered incandescent by the ignited jet of an oxy-hydrogen blow-pipe, invented by Dr. Hare, of Philadelphia, and used with marked success in the British Signal Service, by Lieut. Drummond, has been called the Drummond Light.

This term applies distinctively when a collected supply of hydrogen gas, as well as of oxygen, is required, and when both are alike under heavy pressure and forced through the tubes of the blow-pipe.

Oxygen and hydrogen, mixed in a common reservoir, cannot be safely used in connection with an ignited jet.

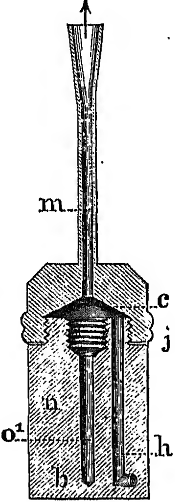
The separate gases, however, may be forced upon the lime through entirely separate jets, in accordance with the primitive arrangement; or, which amounts to about the same in effect, the two currents may terminate in tubes one within the other, called the concentric jet, mingling as before only when projected upon the lime;

pipe.

The mixed jet tube, m (Fig. 39), takes the place of both the tubes of No. 2, covering both apertures at the junction, j.

The oxygen gas forced up through the central aperture o', in the nozzle, instead of being taken direct to the lime by the jet tube, as in Nos. 1 and 2, is allowed first to mingle with the hydrogen forced in with equal pressure at the side aperture.

The relative quantity of each gas is regulated by the stop-cocks till the best effect is produced, which, in theory, is when there are two volumes of pure hydrogen to one of oxygen, or about equal volumes if coal gas is used.



No. 3, Fig. 39.

DANGERS PECULIAR TO No. 3.

Serious accidents in operating the mixed jet are mostly occasioned by carelessly collecting or transferring one kind of gas into a bag partly filled with another kind, and then attempting to use it in connection with an ignited jet. It is common to distinguish the bags by the letters *H* and *O*, and it is further recommended to

quire patience, and either a surprising degree of carelessness, or else considerable skill directed to this end.

It should become habitual to turn off the oxygen at least, when the light goes out, and to turn it on only after the hydrogen is lighted.

Stuffing the cavity of a mixed jet with wire gauze is now discarded as not only useless but as often interfering with its successful working.

Passing the gas through a small wash bottle is designed to prevent the back flow of gas or flame. The same advantage is claimed for a valve in the tubing, open towards the jet but closing against any back current.

The best expedient, however, is to use good apparatus, and to exercise common care.

ANNOYANCES PECULIAR TO THE MIXED JET.

The hydrogen flame is somewhat liable to be blown out by too abruptly turning on the oxygen. In this case we have but to turn off the gas and proceed again with more care.

The mixed gas in the cavity *c* sometimes explodes and the ignition may continue within the cavity. Whether the flame is extinguished by the explosion or not, the oxygen should be at once shut off; the jet, if hot, should be cooled, by waiting or by wetting it, and the adjustments should be revised and regulated. This accident

generating pure hydrogen, which is but little if any better.

LIME-LIGHT ADJUSTMENTS.

The lime wheel is two inches in diameter and five-eighths of an inch thick, so that the available surface at its circumference is six inches long by five-eighths of an inch wide. These wheels, lying one upon another, are kept dry in an air-tight box shaped to a dozen of them. Lime is less liable to crack if thoroughly dried before using, as upon a hot stove or upon live coals, or, as is usual, in the hydrogen flame.

After lighting the hydrogen (vapor or gas) in moderate force, and allowing it time to heat and dry the lime, the oxygen is turned on till it nearly cuts down the flame, producing an incandescent spot on the lime wheel, which is struck obliquely on the rim just below the middle of the front, about a third of an inch from the mouth of the jet; it may be brought somewhat nearer if the mixed jet is used. The direct light cannot be seen from behind, but its comparative intensity and its distance from the jet are distinctly seen, without harm to the eyes, as reflected from the surface of the condenser. The upper part of the lime wheel and the inclined cap and door, front and back of C', Fig. 43, intercept the light in the direction of the open top, while the upward draft, the range of the jet, and the side screen plates (not shown in the cut) all favor the ready escape of heat.

or less, according to the quality of the lime and the force of the jet. The wheel lies loosely in its holder, and being a non-conductor, is not very hot at the back, so it can be conveniently turned by the thumb and finger.

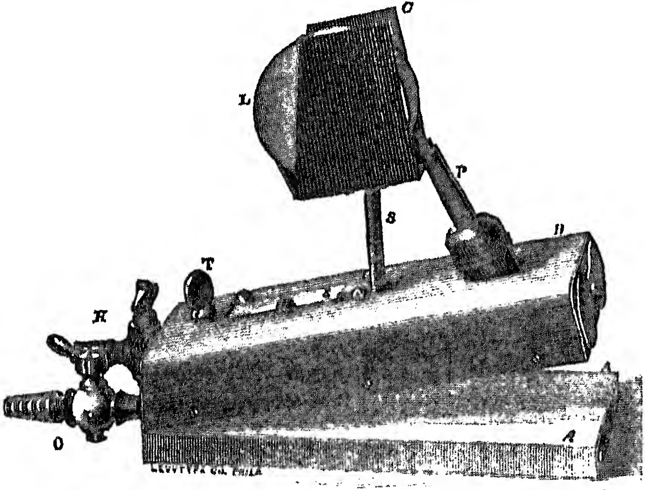


FIG. 40.

The jet is made higher if necessary by screwing feet under the bottom of base A A. The upper part B is hinged to the base, and is raised or lowered by the screw T. The base of the lime cradle S S slides forward or back under screwheads.

ing at i, and the outgoing slide, which is stopped at m or n. It is held by the pins I I entering the lantern base.

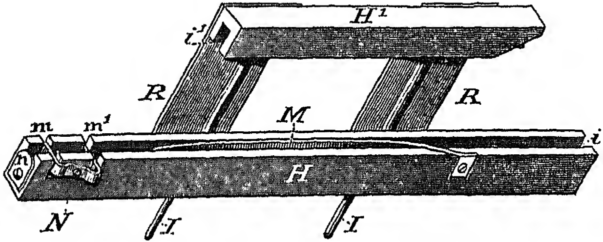


FIG. 41.

When American slides $4\frac{1}{4}$ inches long are used, the outgoing slide is stopped by the catch n, which in its turn stops the slide on exhibition in its place at M; then it is lifted out to make ready for the next move. Four-inch slides are stopped by turning up the button at m, and three-inch slides are stopped by turning the same button up at m′. If the slides are mixed or irregular in shape, the button is kept level, and the slides are gauged by the side of the condenser. It may be used for glass slides instead of the regular cut-off stage, by cutting away the side of the groove m m′ from R, and attaching to it the lever that operates the latch.

This is the slide-carrier to which a pulley and crank are attached, with belt, for moving slides across the field of view at a slow and steady rate, like a panorama. It is

tiful curtain and exhibit thy production." "That beautiful curtain is my picture," replied the rival. "I am fairly entitled to the premium, for even a competing artist unwittingly testifies to my skill."

The surpassing excellence of projected pictures consists in their presenting, on a large scale, the appearance of reality in a marvelous degree, and in their thus presenting, with the least possible expense and trouble, the objects worth seeing in all the known world, and the scenes worth remembering ever since the world began.

In practice we should avoid, as far as possible, all unnatural appearances and movements inconsistent with this pleasing and profitable realization. A serious drawback, in an ordinary exhibition, is seeing the views shoved in and out, especially if the movement is not smooth and steady. Alas, for seeming reality, when the scenery that is spread out before us in distant and stately grandeur suddenly contracts into dancing shadows on a white sheet. Even dissolving views, by which the change is effected so charmingly, present many incongruities not to be rationally anticipated in the natural order of things. The Lime-light Sciopticon, however, with its automatic cut-off, called the winker, shows no commotion nor commingling, to weaken the stereoscopic effect, nor any blank of appreciable duration, for suspense. It is more in consonance with nature, and is less hurtful to the sight. It seems like closing the eyes

which can be done by not crowding the outgoing slide forward.

The curtain is closed by a latch operated by the left hand when taking hold of the outgoing slide, and is quickly opened again when the same slide is pushed out by its successor, and its end reaches the latch and leaves the stage. The change may be effected instantaneously, but to prevent any glimpse of movement on the screen it is better to time the starting of (first) the left hand, then the right, by counting one, two. This order soon becomes habitual, when the counting may be discontinued.

Glass slides follow each other in the same way, through the carrier, only each outgoing slide opens the latch at the first notch in the spring.

The operation is not quite automatic, but its effect is just as satisfactory, while it allows the operator to be governed by circumstances as to using it. It is applicable to both oil and gas Sciopticons, and to all sorts of slides. Its operation is natural and agreeable, when well managed.

Doubtless the surest way for an operator with a single lantern to carry on an exhibition without a blunder, is to have the apparatus as simple and convenient as possible, and to slide the pictures horizontally and steadily across the field. A sheath to keep the light from showing between the two as they change, improves the effect. No contrivance yet made, however, can produce with a single

potash should yield 37 gallons, or 5 cubic feet of oxygen gas; or enough to fill the ordinary 30 by 40 inch rubber bag. In common practice, however, it takes 20 ounces to get 5 feet, or a quarter of a pound to a cubic foot.

To facilitate the decomposition at a lower temperature, and to moderate the flow of gas, we mix with the 20 ounces of chlorate of potash about 5 ounces of black oxide of manganese.

To be assured that this black powder is no part charcoal, black lead, sulphide of antimony, or any thing else that will make with the chlorate of potash an explosive mixture, we may mix and heat a sample of a new supply on a scrap of sheet-iron, or in an iron spoon, over a lamp. If it simply melts and dries away, leaving a dark gray residuum it is safe; if it flashes up, leaving a whitish residuum it is unsafe.

For habitual use, it is convenient to keep this oxygen mixture in stock. Put into a box, say 20 pounds of pure chlorate of potash, broken, so as to pass readily into the retort. Add to these white, broken crystals, 5 pounds of black oxide of manganese, and stir the two well together into a dark gray mass. A pint cup is convenient as the measure of a "charge," as it holds besides the manganese about a pound of the chlorate.

THE APPARATUS.—A gas stove, *a* (Fig. 43), where

whenever used the cap *c* must be luted on.

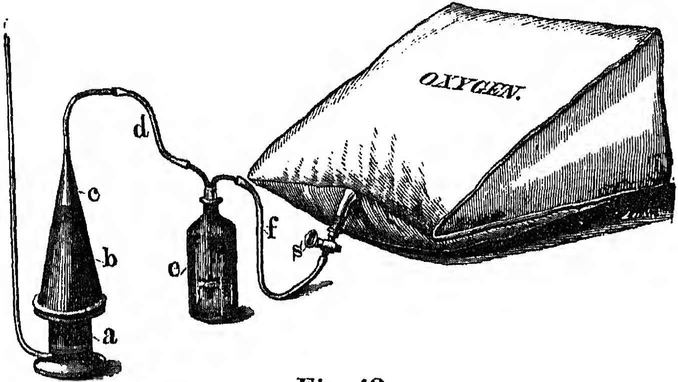


Fig. 42.

The cap has the same bevel as the retort, tapering into a bent tube, the end of which is covered by the flexible tubing *d*. The gas when liberated by heat passes through this tubing, first down the long pipe into the water, near the bottom of the wash bottle *e*, then bubbling up, washed and cooled, it passes over and into the gas bag *O*. It will be noticed that connections are made in all our apparatus, by slipping the flexible tubing over the ends of the brass pipes, which either have tapering nipples, or are cut with a slant on the under side.

The Operation of Collecting Oxygen Gas.—Pour

flow of gas expels the air; see that the stop-cock is open and that the tubing is unobstructed.

Apply sufficient heat to almost immediately melt that portion of the charge in contact with the bottom of the retort, then as the rest melts in turn the operation will be gradual. A slow fire is to be avoided; for it, after a tedious waiting, raises the whole charge to about the melting point, when the decomposition suddenly proceeds with frightful rapidity, perhaps choking the passages and parting the connections. The connections, however, are so easily parted that there will be at the worst only annoyance and loss of gas, but no danger. It is a common recommendation to abate the heat if the flow is too rapid, but with a good heat from the start, the operation is expeditious and safe.

When the bubbling ceases and we conclude from the quantity of gas that the charge is spent, we disconnect the retort and remove it from the fire, and close the stop-cock at the bag.

It rusts the retort less to break up the residuum with a rod, getting it out dry; but it is easier and perhaps better to pour in water and rinse it out, drying the retort directly afterwards.

PREPARATION OF HYDROGEN GAS.

Hydrogen, one of the constituents of water, is pro-

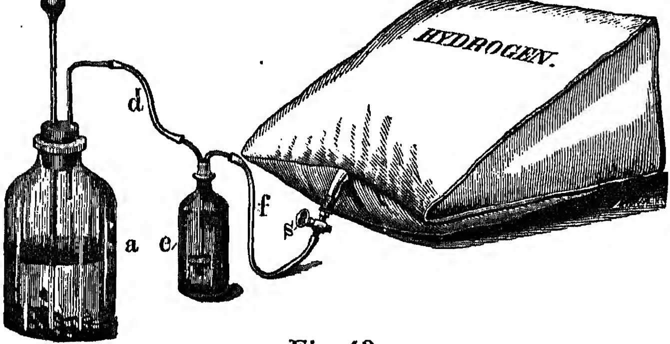


Fig. 43.

About two pounds of zinc is introduced into the generator (a glass bottle to hold five gallons or more, or a vessel made of lead), the top of which, bearing the tube funnel and bent exit tube, is then replaced, and the joint being made airtight (in the case of a leaden generator by means of a screw, and in the case of a glass bottle, by a metallic stopper coated with rubber), the diluted acid is poured down the long tube funnel *b*, the end of which descends far enough into the liquid to prevent the return of gas in that direction. A brisk action ensues, the gas effervescing like so much soda-water. The first portions should, however, be allowed to escape for some minutes at the outlet of the wash bottle *c*, to expel the air. To ascertain when hydrogen

would be none without them. We can judge near enough from appearances when to complete the connection.

Where the precaution of diluting the sulphuric acid and allowing the mixture to cool has been neglected, and sufficient time cannot be allowed for the purpose, the zinc and water may be placed in the generator, and the concentrated acid slowly poured down the tube funnel as it is required.

It is equally important that, before collecting the gas, the bag in which it is to be received should be pressed quite flat, or rolled with the stop-cock open, so as to exclude all trace of atmospheric air. The time when pure hydrogen is coming off may be known by the rapid rise of the bubbles to the top of the water, and by the accompanying sound, which the ear will recognize, after a little practice, as being unlike that of other gases. The purifier *c* should be about half filled with water; and connection being made between the exit tube *f* and the gas bag by means of india-rubber tubing, as shown in the cut, be careful to turn on the stop-cock *s*, in order that the gas may have free entrance into the bag.

The process here given is the simplest of the several in common use, and the best for collecting hydrogen gas in a not very large quantity. The self condensing gas cylinder, to be next described, promises to supersede the more complicated methods, so that their insertion here would be useless.

pressure boards to open from the line of contact, two long leather straps, pierced with holes, may be permanently attached to the lower board and hitched to screw-heads on the upper board, allowing it to be in a plane nearly parallel with the lower board, while the bag of gas is between them and the weight bears on the side opposite.. These straps may be hitched up, from time to time, as the gas is expended. By giving sufficient length to these strap-hinges, the two bags for the mixed jet may be placed one upon the other and subjected to the same pressure.

The three boards hinged together in the shape of the letter Z, to receive a bag in each angle, as commonly recommended, are not only heavy and expensive, but a measure could hardly be devised more likely to give unequal pressure. A long board extending from one bag to the other, with the weight upon the middle, would be better.

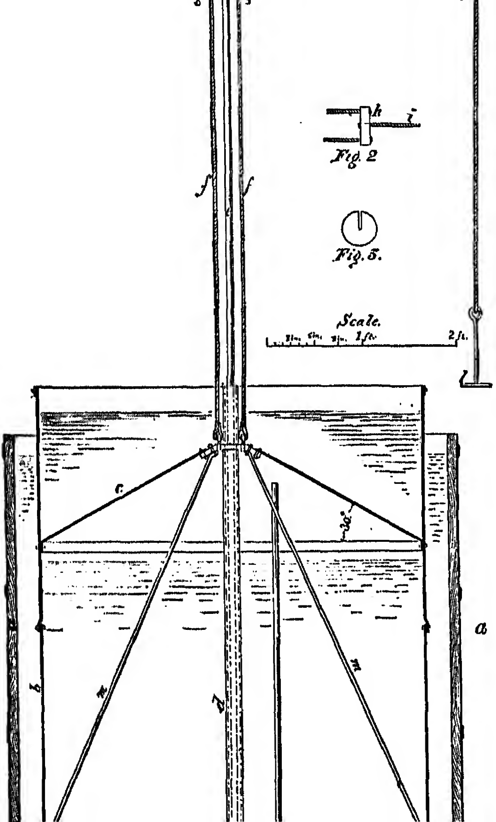
The necessity of exactly equal pressure to be given to the two gases used with the mixed jet, is not so absolute as might be inferred from the way it is usually spoken of. It is surely well to see that the bags are about equally weighted. When two gas cylinders are used, one nearly spent need not be mated with one fully charged. If, however, the pressure in each is in excess of what is needed, the stop-cocks are made to regulate the flow.

As it is inconvenient to transport heavy weights from

"In the summer of 1875 the Franklin Institute determined to put in a pair of holders of considerable capacity, for oxygen and hydrogen, so as to avoid the necessity of preparing the gases on each occasion that they were to be used, and other inconveniences in the use of bags and press-boards in connection with the lime-light. As it was desirable to use as great economy as was consistent with effectiveness and durability, the design shown in the accompanying illustration was adopted, as covering these points.

"Fig. 44 is a sectional and Fig. 45 a perspective view. *a* represents a wooden tank or tub, 4½ feet in diameter, and 5 feet high, made of cedar wood, and hooped with iron in the usual manner; *b* represents the holder, made of No. 10 galvanized iron, and is 4 feet diameter by 5 feet high. The roof or top, *c*, is conical in shape, rising on each side at an angle of about 30°, and is attached to the sides of the holder 18 inches below the top edge, thus forming a receptacle for water, to act as a weight to produce the required pressure when the gas is being used.

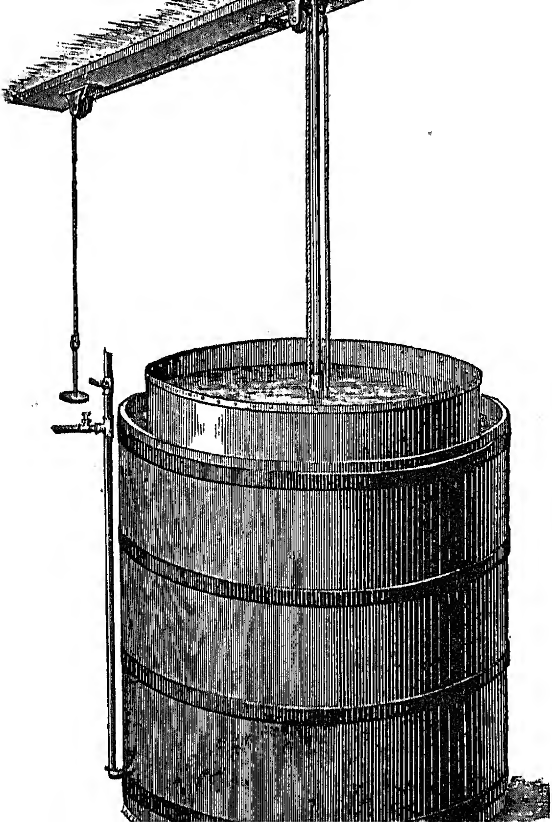
"In the centre of the holder, and extending its extreme height, is placed the tube *d*, passing through and fastened by a water- and gas-tight joint to the roof *c*, and being held firmly in the centre, at its lower end, by the four braces *n*. The holder is given additional stiffness by the diagonal braces *m*, which, however, may be dispensed with in holders of this size or smaller. From the centre of the bottom of


h
i
Fig. 2
Fig. 3.
Scale.
1 ft.
2 ft.
f
f
c
30°
a
b
d
m
l

ff, up to and over the pulleys *gg*. After passing these pulleys or shrives a few inches (the holder being at its lowest point), the ends of the cords are inserted and fastened in holes in the crossbar *h*, as shown in Fig. 2, p. 169. Midway between these cords is inserted, from the opposite side of the crossbar, a single cord, as is also shown in Fig. 2, p. 169, as well as in Fig. 45, which represents this portion broken off and swinging around at a right angle to its proper position. This cord *i* passes over the shrive *k*, and extends down to within a convenient distance of the floor, and has attached to its extremity the pan *l*, for holding the weight shown in Fig. 3, p. 169. Care must be taken that the distance of the shrive *k* from the crossbar *h*, and also from the bottom of the scale pan to the floor, is as great as the proposed rise and fall of the holder. The arrangement of cords, shrives, etc., will be readily seen in the perspective view.

"The pipe for the admission and exit of the gas is shown as passing through the side of the wooden tank, and rising near the centre, to within a few inches of the top of the holder.

"The manner of using is as follows: The cock *o*, in the inlet pipe, being open to the atmosphere, water is admitted to the tank until it rises a little above the lower edge of the top of the holder, when the cock should be closed. Weights (Fig. 3, p. 169) are placed on scale pan *l*, in sufficient amount to overbalance the weight of the holder, and to overcome the friction of the cords and pulleys. Communication being opened between the inlet pipe and the source



the holder is ready for refilling.

"Where the oxy-hydrogen light is much used, holders are almost indispensable, and in all cases effect a large saving of time and material in the preparation and use of the gases."

The above illustrated article has been prepared for the purpose of affording a practical guide in constructing similar gas-holders, wherever the plan is approved. If the tubs are made at any distance away, they can be brought in parts to the place they are to occupy and there set up. The joints of the galvanized iron holders are made gas-tight with solder.

Wherever illuminating gas is in use, the hydrogen gas holder can be filled with it, as is done at the Franklin Institute. If either the alcohol burner, or the concentric jet with house gas direct from the main is used, only an oxygen gas holder is required.

So far as we now know, it seems best to generate the gases by repeated use of the apparatus described on pages 162 and 164. With two retorts, one accustomed to the operation can roast a double oxygen charge in each alternately till eight pounds are used, which about fills a gas holder of the dimensions described.

The use of gas holders renders projecting apparatus much more available in educational institutions, because the gases can be made in large quantities at once, stored for an indefinite time without deterioration, and used whenever occasion requires, without delay, with only such darkening

A copper hydrogen generator, about thirty inches high, similar in shape to Fig. 45, but with the zinc suspended so as to sink into the acidulated water, to keep up the supply of the disengaged hydrogen as it becomes expended, has been in market for many years; but its being abandoned by those who have used it is not very assuring.

A good light is produced by vapor from heated gasoline, or other hydrocarbons, pressing into the mixed blowpipe, but it can hardly be as safe as a jet of oxygen through an ordinary alcohol flame.

At this very time there is much said in favor of generating oxygen at just the rate required by the jet, by gradually feeding the oxygen material to the melting apparatus. We are now waiting to see this process develop into complete success, but the question arises as to whether the additional care of generating the gases while running the light will not prove too much for ordinary faculties, and result in the proverbial experience occasioned by having too many irons in the fire at once.

The gases, with the use of cylinders, into which they are compressed by pumping, are furnished by dealers at about 20 cents a foot for oxygen, and 3 cents a foot for city gas. Many exhibitors in the vicinity of large towns are thus supplied.

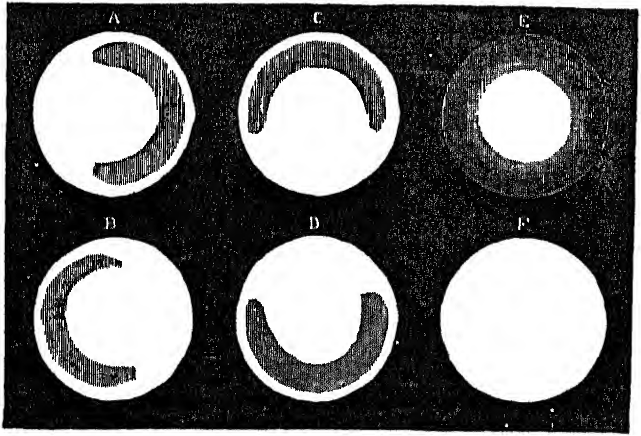


FIG. 46.

If the right side of the disk on the screen appears dark, as at A, the jet is moved to the left by turning both side-screws in the lantern base forward with a hand on each. If the appearance is as at B, the jet is moved to the right by turning these screws back. When the sides are clear the jet is tightened by turning both screws on. If the appearance is as at C or D, the jet is lowered or raised by the screw D, Fig. 48, page 177. When the light is too near the condenser, it produces a bluish darkness about the centre, as at E, and when too far back, the margin becomes discolored by a yellowish fringe; so the

small fraction of the extended portion is available. The Oil-Light Sciopticon, as settled upon and already described, has now stood the test of a long trial, and is not found objectionable in any particular. The oil is not heated, the glasses are not broken, the draught of air can be increased as the oil burns up more freely, the parts are easily adjusted, and the narrow keen light gives a sharp bright image—so there is little need for varying former descriptions.

But in issuing the seventh edition of the MANUAL, it is expedient here to describe our later improvements in the Lime-Light Sciopticon, the Jet, the Lime-Light Made Easy, the Electric Light, etc., to specify peculiarities, and to explain more fully the general principles of Projection.

In order to use larger condensers as well as the most approved form of the vertical attachment, the brass cells for the two elements of the larger condenser are hinged together and held in place by a pin. The back cell is held to the shortened Sciopticon body by a bayonet joint.

For the vertical attachment the front element of the condenser opens to a horizontal position, and is held in place to a tall draw-front, which holds the objective and mirrors in the usual form.

These condensers, the vertical attachment, and the achromatic microscope attachment are only used with the lime light.

The safe use of gasoline in the hydrogen-gas generator, which so greatly lessens the trouble and expense of the lime light, claims particular attention. A glance at this line of apparatus, with directions how to use it, may not

without flame chamber or regular chimney, but a lid hinged above the condenser, and shutting its sides down into the square top, serves as a chimney when open, thus economizing space, carrying the heat up and back from the lenzes, preventing the escape of direct light, allowing the operator, without opening the door and without hurting his eyes, to see the exact condition of the incandescence as reflected from the condenser, and showing the slides, etc., if held to the opening.

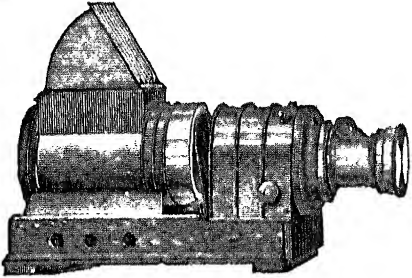


FIG. 47.

The draw-front has now a metallic carrier to slide in the grooves below, which accommodates the internal arrangements better, is more adjustable to the optical alignment, and is not, like wood, liable to shrink and swell.

There is a small blue-glass aperture in each side, near to the incandescent lime, and screws in the base for adjusting the jet, which are not shown in the cut.

here shown; the thumb-screw C turns the lime steadily, and raises or lowers it a quarter of an inch at each revolution, so the incandescence is on a fresh surface at every movement through the longest exhibition; the thumb-screw E varies the nearness of the lime to the jet, and all are close at hand to be managed without elevating the lantern on posts to reach under, or opening side-doors on spectators.

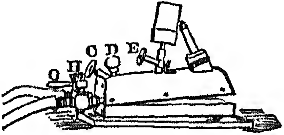


FIG. 48.

This Jet, in size and shape, is suited to the Lime-Light Sciopticon, but its base can be made thicker if necessary, or raised by foot-screws to suit any other lantern with an open chamber. It cannot so well be used in the Oil-Light Sciopticon because the flame chamber in it is a permanent fixture, to insure its working to the best advantage. The oil-lamp and flame chamber, however, is fitted to the gas-lantern chamber, and any lamp, with its oil-cup fitted, can be used in it, just as in any lantern. This property of adaptability is common to all open-chambered lanterns.

To have the Oil Sciopticon and the Gas Sciopticon each at its best, each chamber and base is fitted with its appro-

having a complete series of strands of absorbing material stretched crosswise throughout, to be charged with as much gasoline of about 88 gravity as will be held by capillary attraction when the free fluid is drained off. The air or gas forced along this narrow way by the blower is compelled to meet every fiber of the entire mass of moistened material with equal resistance throughout, and so becomes saturated with vapor without the agency of heat, affording a most excellent and uniform burning gas for lighting and heating purposes.

This vapor has advantages, not only in quality and cheapness, and in availability where coal gas is out of the question, but it is used where safety is a special requisite. The gasoline in the generator, held captive by the fibers, can be lighted only as the gas is formed and forced out through the exit cock into the air by the blower. The disadvantages of having free fluid to slop or spill, of having a varying quality of gas as the free fluid becomes less volatile, or of having the gas chilled and exhausted by passing through a short or open channel, are remedied in this Hydro-carbon Gas Generator, of the Frost patents.

As an adjunct of the lime light, this generator, of a size to match, is peculiarly convenient and economical, for the oxygen pressure carries forward both elements, with no increased expenditure of oxygen, and little or no increase of weight on the pressure boards.

lamp. This 150 fire test is more trustworthy than the 50 gravity test, measured by Beaume's hydrometer, because a heavier and a lighter oil may be mixed to 50 gravi y, and yet be as dangerous as the lighter ingredient alone. The oil in the lamp is vaporized by being drawn up by the wick into the flame itself. Its safety consists in its not heating the fountain up to the fire test. Any kerosene oil suitable for a common house lamp, is all right for the Oil-Light Sciopticon.

Gasoline of 75 gravity is usually vaporized by heat at the end of the passage leading to the flame. Its safety consists in having good and well-regulated stop-cocks which permit the flow at the exact rate required by the flame. Most of the gasoline sold about the country is for this class of burners, requiring heat. It is utterly unfit for use in the hydro-carbureter.

Gasoline of 88 gravity saturates the air or gas in contact with it at ordinary temperature. The volatile particles separate from the surface, and the larger the surface exposed to a current of air or gas, the more rapidly will the fluid be changed to vapor.

The vapor taken up by oxygen from the closed vessel shows the influence of the oxygen only in its burning without smoke. It has to be met by an independent supply of oxygen to bring it to an explosive mixture, as in the mixing chamber of the jet. Its safety, more than the other fluids named, requires that the vessel shall not leak, and, as we put it, that there shall be no free fluid in it, but only a moistened material, filling the whole space; and that the long narrow passage in the space shall be constructed in

ing material in this miniature generator absorb about three pints of gasoline, or enough to last ten hours or more. It is well, however, after each exhibition, to replenish it by an additional half-pint, or enough to re-saturate the material, to insure its being always ready. It is charged by opening the side or outlet cock A for vent, then removing the middle stopper and using its socket as a funnel. In

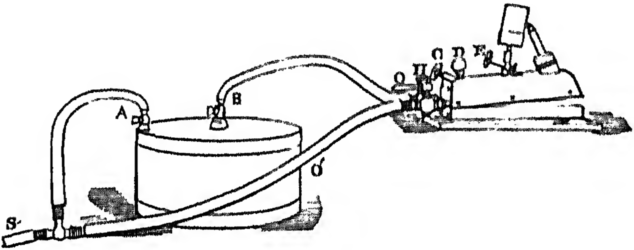


FIG. 49.

practice it can be replenished so as seldom to have much if any to pour out.

As is generally known, gasoline should not be poured out close to a fire or flame, as the escaping vapor is very inflammable. We may avoid candle-light and disagreeable fumes by doing this work by daylight, in the open air. As the vapor is heavier than air, it will not escape from the generator even while the cocks remain open, because

about it, except when receiving the charge. There is no free fluid to slop or spill. So we have in this small generator, with no tendency to escape, more of the hydrogen element than is contained in the largest gas bag or cylinder, and in a state to readily combine with air or oxygen, to produce a burning gas which is in the fittest condition to be brought to a focus on the lime by an independent branch of oxygen.

The vapor taken up by the air or oxygen is not explosive while the charge lasts, and it would last hours longer than the longest exhibition; and it cannot explode in the generator at any stage of exhaustion, because the spiral passage is filled with cross strands so closely and tightly drawn as to prevent all tendency to vacant space. It has repeatedly been worked dry with oxygen, on purpose to explode it if possible, but without being able to effect such a result. When dry, after many hours of continuous work, it can be made to snap in the tube of the stop-cock, and the material can then be lighted inside, like a fuse, if oxygen is continuously supplied; but no one cares to run it ten hours or more without filling, unless it be for the purpose of experiment.

Methods of Using the Generator.

Hitherto the concentric jet has been required for house-gas direct from the main, but reinforced by the generator, it works well in the mixed jet, while without this reinforce-

doubtless be preferred by many, as the oxygen in it saves that much of the supply.

But oxygen itself, whose power of taking up inflammable vapors has long been recognized, is the most convenient agent to use in connection with this generator; for the pressure to which the oxygen is subjected to bring the flame to a focus, is available also in producing the flame. The current of oxygen from the supply (below S, see diagram, p. 180) is in this case divided, by a T connection, into two branches, one branch passing through the generator (in at A and out at B), and controlled by the hydrogen key H, at the jet, to feed the flame, and the other branch passing through the tubing 6, and controlled directly by the oxygen key O, to bring the flame to a focus on the lime.

Snapping Back.

In this generator the oxygen has no open chamber around or through the saturated material; it has none made for it, and it can make none for itself, through which it can, under any conditions escape licking up its fill of vapor, when charged as directed, or in which it can get up an explosion. There is some open space in the tubes and jet, which, however, is so small that an explosion in it is called snapping back. This may occur if the charge is allowed to become exhausted.

a yellowish fringe, just visible. The worst feature in the jet snap is the possibility of its continuing to burn in the chamber. This mischief may be known by its making the jet hissing hot, which should be immediately stopped by shutting the key O.

If the oxygen supply has a double stop-cock, one key of which controlling the supply through the hydro-carburet-er, the other key being in independent connection with the oxygen jet-key, then the working of the new way is just like the old oxy-hydrogen jet, requiring the same cautions. But if, as above described, the T connection is used, then the oxygen jet-key must always be closed before the supply key, or else the compressed elastic vapor vents itself at the jet through the oxygen channel, and will surely snap back. So with the T connection—the operator must form the new habit of shutting off the light by first closing the oxygen cock at the jet.

Dealers mostly have occasion only to keep the heavier gasoline, requiring to be heated by the burner. If such an article is put into the hydro-carburetor, it will snap back if it lights at all; it may make the lime incandescent without the turning on of the oxygen key, in which case it is unfit to be used. The charge may as well be exhausted as to be of the wrong material. Gasoline of 88 gravity is used in all the gas machines which are operated by a blower. It is usually sent by the wholesale dealer, however, direct

—1. Do not allow the charge to become exhausted; 2. Let on gas enough, especially of hydrogen, to make a fair-sized incandescence; 3. Shut off the light by first closing the oxygen cock O at the jet; 4. Don't shut it off with a jerk.

No Back Pressure can Reach the Supply.

It may be seen in this connection, that in this system the only direct pressure comes from the oxygen supply. The little that spills over towards the jet when the current is first stopped is not felt back of the T connection. The closed stop-cock which keeps the supply from getting out, though it presses hard to get out, will keep what is out from getting back, for it does not press at all. The vapor remaining in the generator being heavier than air, will remain at rest till again pushed forward by the supply.

With two gas-holders under different degrees of pressure, one gas can be driven through the mixing chamber of the jet into the other, but with only one it is impossible. With two gas-holders, one kind can be carelessly emptied into the other, which is sometimes done, but with this apparatus, such a blunder is out of the question.

Thus in our persevering search for dangers, we really find none; not even such as belong to the old apparatus. We may fairly conclude, therefore, after a full examination, that this system of apparatus is the easiest, cheapest,

1. It requires but one gas-holder. It doubles the troubles to have two, especially if out of reach of coal-gas.

2. The one pressure carries forward both elements, so its running down does not disturb the even balance. We vary the intensity of the incandescence by the one supply key. Turning two in succession, as in the old way, disturbs the equilibrium, and mars the exhibition.

3. More of the hydrogen element reposes in this miniature gas machine than can be compressed into an ordinary bag or cylinder, while it has no such tendency to escape.

4. The hydrogen element in the generator does not deteriorate, or waste, or injure the holder. It will keep indefinitely.

5. It supersedes the necessity of resorting to the concentric, or to the alcohol jet.

6. It does away with the cumbersome and troublesome apparatus for making and storing hydrogen gas.

7. It makes the best light as attainable in the country as in the city.

8. Gasoline with this machine yields a uniform quality of gas. The oxygen licks up vapor from every fiber in its lengthy passage, so there is no injurious refrigeration, or precipitation of the less volatile portions, as in surface vaporizers. Some hydrocarbon fluids vary much in quality, and necessarily contain more or less water; but gasoline is anhydrous, and a standard quality is supplied by the trade.

cities there is but little additional expense in having the gas supplied in both cylinders, and operators are used to it. Much of what I have here said, and all that I have heretofore said, is applicable to the older methods. The customer, who pays his money, takes his choice.

ABRIDGED DIRECTIONS.

The generator is charged with as much gasoline, of about 88 gravity, as will be held by capillary attraction when the free fluid is drained off. The charge is poured into the socket of the middle stopper B, after it is removed and the cock A is opened for vent, and then the overcharge is drained back.

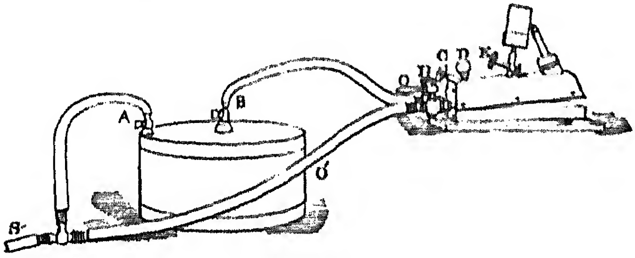


FIG. 49.

The connections and keys of the generator and jet are best seen in the diagram as here arranged (which is here

is attached to the oxygen cock O.

Insert the lime in its socket at the same angle with it, so it will keep the same position when revolved, and set it by the screw E, just so as to clear the jet as it revolves; turning to the left pushes the lime nearer, turning to the right draws it away. When in the lantern and lighted, its nearness to the jet's mouth can be seen through the blue glass in the lantern's side.

The Sciopticon, with its door open and its lid raised, receives the jet arranged as shown, with the keys H and O projecting.

NOTE.—The pressure of gas pumped into a cylinder by steam power is 200 pounds to the square inch, more or less, which is controlled at the cylinder by its key. The bag pressure, produced by weights, is less than one pound to the square inch; so the bag stop-cock is left wide open when in use, and the pressure is regulated by the cocks at the jet.

Operating with the oxygen cylinder.—Close the oxygen cock O at the jet, and open wide the hydrogen cock H, and the generator cocks A and B. In lighting up, turn the cylinder key with care, by giving little taps upon it till the light comes up to about the size of a common gas light. If it accidentally gets on too strong, make some allowance, while turning it back, for the subsidence of the elastic force produced by the over pressure.

Turn the oxygen on to this flame by opening the jet-cock O. This will probably not bring the flame to a focus, but

hundred pounds of weight.—The weights upon the pressure-board may be bags of stone or sand, or whatever is most convenient in the locality. Close the cocks at the jet, and open the bag stop-cock, and the generator cocks A and B. Light up as the hydrogen cock H at the jet is opened, and turn on the oxygen by the cock O, turn off the hydrogen that is in excess till the light is sufficiently bright.

Focus a picture on the screen, and then withdrawing it, see that the disk is clear. Push in the jet, to clear off any yellowness in the margin, but not so far as to darken the middle. If the bottom or top is dark, raise or lower the jet by the screw D. If the right or left is dark, move the jet to left or right, by turning both side screws forward or backward, with a hand on each. Tighten the jet by screwing both these screws in.

If the light needs brightening while the adjustments at the jet are all right, turn on more oxygen from the cylinder, or put more weight on the bag. With the bag, however, the light may be running with both jet-cocks partially closed, which may be opened as the light requires.

The lime cylinder is turned by the screw C, a quarter of an inch or so, every few minutes, or as often as the light is improved by it.

In regard to size of disk, and distance of the apparatus from the screen, the ordinary lens (if not too near) makes the picture on the screen half as much in diameter as the

and adjustments to match.

Dissolving Views.

Dissolving views are produced by two lanterns, projecting pictures on the same space on the screen alternately, with a gradual change.

The dissolving cock, fastened to the rear end of the lantern box by screw-heads jutting over the edge of its wedge-shaped flange, has a lever hanging down from its head, by which it is turned from side to side, which turns the gases from one lantern to the other by means of its two T connections. The three nipples of the T near the lever are for hydrogen, marked H, and the three nipples of the T near the flange are for oxygen, marked O. The H and O branches of the supply are attached to the lower H and O nipples, and the H and O nipples on either side are connected by tubing to the H and O jet-cocks of the jet on the same side. The right-hand lantern, say, with the lever turned to the right, is lighted and adjusted like a single lantern, and so the left-hand lantern, with the lever turned to the left.

When a picture is focused in each instrument and withdrawn, bring the lever to the middle, and move the lanterns, pivoted to the screw-heads, so the disks will coincide.

The H slit in the cock is cut so deep as to leave a small light in the off lantern, but the O slit allows the oxygen to

when the lever is in the middle. With cylinder pressure it is different. The small vent allowed by the cylinder key is only just sufficient to supply one light; for an excess cannot with safety to the connections be restrained at the jet. Now when the lever hangs down in the middle, the supply, which is just enough for one light, is divided into two parts; so, at the best, each light can be only half supplied; but it is worse; the off lime takes some of the supply to heat it up again to incandescence; and besides, it is difficult to keep the balance so that each half light shall be at its best with the half supply. So it comes to pass that much of the so-called dissolving consists in letting one picture darken down, after which the other brightens up.

With the gas generator, however, the air pressure principle before spoken of helps fill up the midway deficiency. Now if with this, a little over-pressure is allowed from the supply, and the lever is not allowed to swing its full distance from side to side, only far enough to keep the light at its best without noise, the off lantern, being so nearly ready, will brighten up before the acting lantern, darkens down. By this method, dissolving with the cylinder becomes as even as with the gas bag. It may require some more care in doing it, and it will consume some more oxygen.

A New Double Case.

No available artificial light is so intense and concentrated as the Electric arc light. Variations as to its intensity and its holding to the same focus, however, have hitherto discouraged its use for lantern projections, even by those who have a dynamo or powerful battery current at hand. But we have now, in the Edgerton Electric Arc Lamp, a continuous, steady light, resulting from the Edgerton and Doriot patent feed, and from its being held to the fixed and indestructible iridium point, *i*. See diagram.

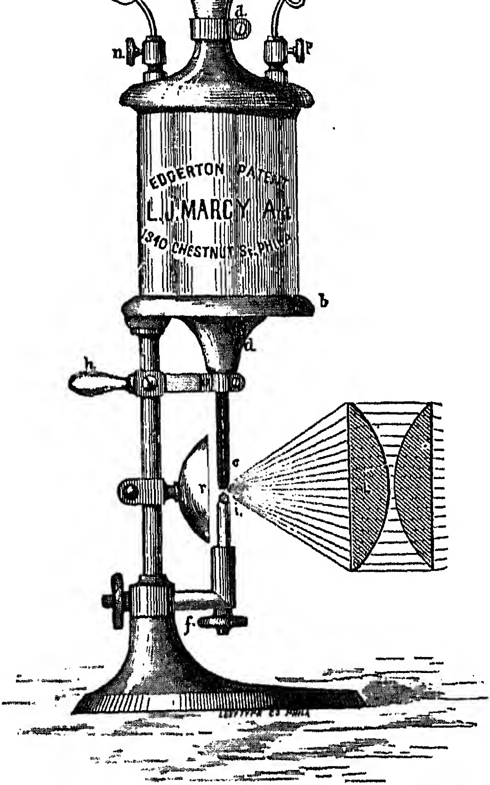
Its intensity is many times greater than the lime light, while it emerges from a smaller space. It performs wonders in microscopic projections. It continues in action and in focus without watching, and it can be switched on or off by a movement of the lever *l*.

Description of the Edgerton Lamp.

The lamp is a single carbon arc lamp, using for the negative electrode an indestructible point of iridium, mounted in iron. This arrangement allows a more simple and steady feed motion than can be attained in a two-carbon lamp, inasmuch as it is only necessary to supply the one carbon at the exact rate at which it is vaporized by the current. This supply is furnished by passing the carbon rod between two metal rollers held firmly against it by springs, and driven by two cog-wheels and a ratchet

no more than a thirty-second of an inch, while usually it is imperceptible. This allows of the glowing carbon point being always retained as a centre of light to focus on, which gives the picture an unusually steady illumination.

As to the external portions, as shown in the cut, *p n* are the positive and negative binding posts. At *a*, a spring is fixed for regulating the weight of the armature to the different currents. The bottom of the lamp-box, *b*, serves as chimney cap to the sciopticon, and the inverted cone *c* reflects the heat away from the open space below. Commonly the carbon is let down through the tube, *t*, but in this focusing lamp a shorter, and narrower carbon, *c*, is inserted from below, and is held by a tube which is itself moved by the machinery; this arrangement being considered more convenient for lantern use. The handle to the switch is handy to the open end of the sciopticon. The reflector, *r*, is adjusted by the screw at its back, or can be removed when not wanted. The elbow holding the iridium, *i*, is adjusted by the screw to the left of *f*, and the iridium is raised or lowered by the screw to the right of *f*. The metallic part of the foot, *f*, is shod by a wooden block, made thick or thin, or wide or narrow, to suit any lantern or other use for which it is required. For the sciopticon this insulating wooden shoe is the width of the lime-light jet, and is adjusted and held by the same side screws. Indeed, no change in the lime-light sciopticon is required but to



lamp itself can be inverted when the space in any lantern

What may prove the best means of producing sufficient electric current is reserved for future consideration.

The Edgerton lamp is used at the Franklin Institute where it is the admired of all observers.

Mr. Holman says:—

"The projecting microscope for minute objects requires a steady light of great intensity at a fixed point. Sun light is intense, but not under control as to time and place. The lime light is steady, but not sufficiently intense to magnify to a large size a very minute object; increasing its power increases also the area of incandescence beyond what is available on so small an object. The positive electrode of the arc electric light gives greater intensity from a smaller point, but has hitherto been found unsteady, and of variable focus. It is now found, however, that the Edgerton iridium electric lamp answers all requirements in a very remarkable degree. I have the lamp which I use inverted, as thus it seems to me best suited to the 'Holman Lantern Microscope' of the Franklin Institute. I find it works equally well in that position as when erect. I obtain very satisfactory work from it; the light being very steady and clear, giving good definition up to three or four thousand diameters, with illumination enough for double that magnification. For class demonstration in general I think it a great acquisition, as the amount of light is so great as not to require the entire darkening of the room. D. S. HOLMAN."

lenses than can well be used with an oil-light lantern. These properties and variations may, therefore, receive further consideration here, and in the order of the general optical arrangement previously shown on page 25.

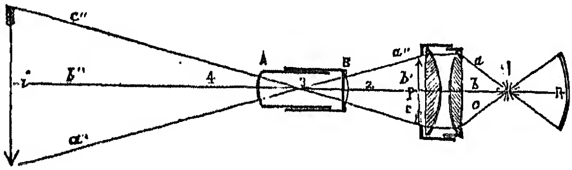


FIG. 51.

THE REFLECTOR

May utilize a portion of the backward rays of the electric light, as it does that of the flame of a lamp or of magnesium wire; but the lime light has no back rays to be reflected. When used alone, the reflector may to advantage be large and parabolic in shape, but acting with a condenser, it must have the light 1 in the centre of concavity, so it may reflect the rays back through the light in the direction of a b c.

CONJUGATE FOCI.

The diverging rays from 1 are rendered nearly parallel by the collecting lens, and then are converged by the condensing lens, through the picture slide at its surface, to the objective, by which the inverted image of the picture is made sharp at its conjugate focus on the screen. The

f on the screen at i, is in the conjugate focus of the objective.

THE SIZE OF CONDENSERS.

The common size of the Sciopticon condenser is 4 3-16 inches, to insure a 4-inch clear diameter. This size illuminates the 3½-inch opening of the new-departure wood-mounted slides, and also the 3½-inch diagonal opening of the crystal slides, with enough spare margin for any but careless variations in placing them. It, however, rounds the angular corners of square slides a little; but there are not many such in market—the mats of nearly all square slides being made with rounded corners.

The clam-shell condenser, so called from its being hinged at top to allow the raising of its front lens to a horizontal position for use in the vertical lantern and for experiments, etc., is made with 4½ inches clear diameter, which over-reaches the right-angled corners of the slides three inches square. We also make a 5-inch clam-shell condenser, but we think the 4½-inch size is better for ordinary purposes. Some prefer a 5-inch or even a larger condenser for 3-inch slides, thinking that it illuminates them better—but it is easy to see that light falling outside of the clear opening of the slide, serves no good purpose; it has to be masked to prevent its reaching the screen outside the slide-frame.

A very large condenser, with slides large in proportion, uses more of the light; but there is the disadvantage of

gathering of all the rays where the microscopic attachment is placed, the light is white and even.

The collecting element of the condenser often has an added lens behind it in the same position, but generally smaller, as, being so near the light, it catches all the rays that it can bend to the two larger lenses in front. The difficulty of obtaining clear glass thick enough for very large lenses of short focus, may in some cases make it expedient to use three thicknesses. There has been much said and written in favor of the triple condenser, and also in favor of an accurately prescribed system of curves in it, which may be of appreciable value; but for the sizes above mentioned, it seems unnecessary to add two more surfaces of glass for the light to pierce.

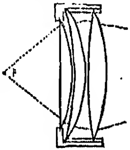


FIG. 52.

THE CONDENSER PRACTICALLY ACHROMATIC.

The condenser, after separating the light into prismatic colors, evenly re-distributes it on the picture, so as to produce homogeneous light, like its source. A non-achromatic objective, however, gives fringes of color, because an even distribution is prevented by the markings and shadings in the picture. It also produces an indistinct image because the focused pencils of light are spread by spherical aberration. Some colored rays, at the margin of the condenser, not supplied with their affinities, are in practice cut off by

gram, equalizes the several refracting angles, and gives a more even illumination. For reasons for which both the condenser and objective are responsible, the middle portions of the disk on the screen are somewhat the better lighted; which, however, gives better effect to what are usually the more important parts of the picture. For Aberration and its causes, see p. 16, etc.

OFFICE OF THE OBJECTIVE.

Without the condenser, its light would be spread over a plane, at 3, of over 60 square inches, the middle rays of which would barely make the middle points of the picture visible on the screen. Without the objective, the diverging pencils from every point in the picture would spread over the screen, so there would be no image at all.

If the light 1 (Fig. 51) could all proceed from a mathematical point, and be refracted without aberration, then a b c, being without marginal rays, would correctly illustrate the individual rays filling the whole space between, as further shown in Fig. 50. The focus would be a mere point at 3, Fig. 51. The screen at 4 would show an inverted image, either with or without an objective, of a size depending mainly on distance.

But light necessarily occupies some space, and though pencils of rays from each point in it are focused in a plane at 3, making there an image of the light, yet the objective

area of the light, the more the objective has to do, and the less perfectly it does it.

PENCILS OF LIGHT ILLUSTRATED.

By using a lantern in a dark room where there is considerable floating dust or smoke, we may see the course of light as outlined in elementary diagrams, but we cannot separately see the pencils of diverging rays proceeding from every point in its course, nor the pencils of converging rays proceeding from every conceivable space in it. Pencils of light, however, which we cannot separately see, may be outlined in diagrams, and correct theories thus illustrated can be verified by experiments.

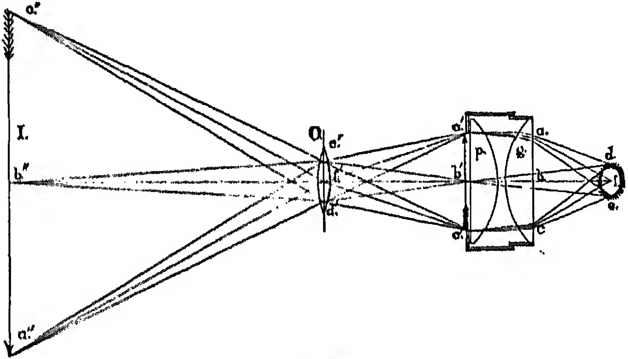


FIG. 53.

Fig. 53 represents the axial rays a b c, as shown in Fig.

diverging from every point in the light, which pass through the condenser, are focused by it at the objective, as a d c at d′—a f c at f′, and a e c at e′; and converging pencils from the whole luminous space falling upon each point in the picture, and crossing, diverge to the objective, and are conveyed by it to corresponding points in the image, as d e a′ to a″—d e b′ to b″, and d e c′ to c″.

THE MORE CONCENTRATED THE LIGHT, THE SHARPER THE IMAGE.

We thus see that if the size of the light is less, each pencil falls on a less surface of the objective lens, and at a less angle, and is therefore subject to less aberration. That a large area of light tends to blur the image may be proved by a simple experiment. By moving, say a lime light, to the right and left of its true place in the lantern, a half-inch or so, we perceptibly move the image on the screen. This effect is exaggerated if out of focus as it necessarily is a little somewhere, even with the best lenses. The image of a vertical line in the picture, made by one side of a wide light, will not therefore coincide with the one made by the other side, and not exactly with the one made by the middle. How, then, is an exhibition with a bulky light at all tolerable? Really, the centre of the light, being all available, is the most effective; so the dimmer spread of the image is hardly taken into account at a distance, but close

object, is diffused by it in all directions—only a very small part of it reaching the objective lens, and that in pencils of too wide an angle to be sharply focused. Objects with polished surfaces show brighter and sharper, because the light is less diffused.

THE RANGE OF OBJECTIVES.

Supposing the light 1 to be 2½ inches from the back face of the condenser, then multiplying this by the numerals 2, 3 and 4, in Fig. 51, we have 5, 7½ and 10 inches, which are about the distances from the front face of the condenser, of objectives 5, 7½ and 10-inches focus. The diameter of the image of a 2½-inch circular picture made by these lenses, is a half, a third, or a fourth of the measure of its distance away. For these coincidences they have come to be called half-range, third-range, or fourth-range. For example, to produce a disc of 20 feet in diameter, the half-range requires a distance of 40 feet away, a third-range a distance of 60 feet away, and a fourth-range a distance of 80 feet away, etc. A half-range objective matches a condenser of 3-inches focus, but for the third or fourth range the focus of the condenser should be longer by a fourth, or half an inch.

Moving the light forward, however, moves its focus forward, and drawing it back draws its focus back—having the same effect, within limits, as a condenser of a longer or shorter focus. A light two inches or less from a con-

cannot well match the same condenser to a half and a fourth-range.

THE LONG RANGE REQUIRES A CONCENTRATED LIGHT.

Counting the light $2\frac{1}{2}$ inches back of the condenser (Fig. 51), the objectives of half, third, or fourth-range will be 2, 3 or 4 times that distance in front, and the focused light will be 2, 3, or 4 times its own size. Light half an inch in diameter will pass through the half-range at 2, but not through a fourth-range of the same opening—so we use a larger lens.

We see, therefore, that neither a bulky light nor a small lens is suitable for the long range. We see, also, that a light much in excess of half an inch wide, or an inch and a half deep, is mostly wasted, its effect being chiefly to intensify the heat of the lantern. We see further, that for microscopic objects placed near the focus of the condenser, all in excess of the size of a pin's head is wasted—only, with the lime light we are obliged to produce a larger incandescent spot in order to get greater intensity in the middle. The larger incandescent spot also makes the alignment less difficult.

The Electric Focusing Lamp, described on page 191, is particularly well suited to the exhibition of microscopic objects, not only because it is more concentrated, but also because the objects, mounted in balsam—and especially the

called the screen. It may be a wall, or muslin, or paper, or whatever can be mounted so as to present a smooth, white surface, without gloss.

When a muslin screen is hung between the projecting apparatus and the spectators, it is the common way, and it is the best way, to give it a good wetting. Oil or wax renders the muslin more translucent, which is better, and the application does not have to be repeated at each exhibition; but, if large, it is hard to manage, and it soon becomes creased, and soiled, and yellow, and then there is no help for it. The phantasmagorial effect, once so popular, consists in showing from the back of a wet screen, a ghost, for example—at first small and dim, to suggest distance; then, by moving the lantern steadily away and attending to the focus and light, making it grow larger and brighter, so as to give to the ghost the appearance of approaching the spectators. It is also sometimes expedient to place the instrument behind the screen, for ordinary exhibitions, in order to keep it out of sight and out of the way, or to accommodate the room.

For the most part, however, the projecting apparatus is used to the best advantage in front of an opaque screen, which, so far as practicable, should be so opaque as to waste no light by transmission, and so white as to lose none by absorption.

For a permanent screen, it is a good way to stretch the

swers for a screen, say ten feet wide; but a wider screen requires a heavier roller to keep it from sagging, and from becoming at length permanently crooked. The crook can be counteracted somewhat by keeping it rounding-side up when not in use.

A roller-screen of moderate size can also be carried from place to place. Portable supports, which can be adjusted to various heights, may be made of say two strips of board for each side, each three inches wide and ten feet long—one of them to be provided with a collar at its end for the other to slide through, and to be made fast by a thumb-screw through the collar when drawn apart to a sufficient length to wedge between the floor and ceiling, or to a proper length to lean against the wall.

Each support is supplied with a cord running through a hole or a pulley at its top, with both ends reaching the bottom. These supports are erected the length of the roller apart. Two operators, one at each end, unroll the screen upon the floor. Each attaches one end of his cord to the roller, and with the other end they together haul the screen to its place, and then tie the cord to the side supports, or to whatever else is handy.

Sometimes the situation is such that the screen can be drawn up to screw-eyes or some other support in the ceiling, which of course would supercede the necessity of erecting the side supports.

Take 25 yards of 12-quarter sheeting of the best quality, and divide it into three equal lengths. Sew the breadths evenly together with an over-hand stitch, so that when opened and rubbed down, the selvedge will just flatten down. This gives us a screen about 25 feet square. Hem the raw edges at top and bottom tightly over a cord, for strength. Hem the sides 3 inches wide, to allow the poles to pass freely through. Sew into the same seam a strong 4-inch loop, straddling the hem, 8 feet from the bottom, and 8 feet from the top of each side, or hook rings in at these places, and have two guy-ropes attached to each loop or ring, long enough to reach out to screw-eyes in the floor (diagonally front and back) when the screen is mounted to its greatest height. Sew a strong loop or ring very strongly at each corner, but not so as to obstruct the entrance of the poles.

For side supports get 10 ash poles, each 6 feet long and $1\frac{1}{4}$ inches in diameter, which gives us a set of 5 for each side. Take 8 pieces of brass tubing, each 6 inches long and $1\frac{1}{4}$ inch outside diameter, and have the ends of the poles turned down so as just to fit the sections together with these sections of tubing, thus making two poles, each 30 feet long. Rivet each tube to its bottom section, leaving its upper part as a free socket. Bind with a ferrule the bottom of each bottom section and the top of each top section. Insert a spur into the bottom of each bottom sec-

the guy ropes. Elevating the screen requires a person at each side, with one or two assistants for each, to hold the guy-ropes. Let each end-man run his bottom section of the pole through the entire length of the hem on his side of the screen; tie one end of each pulley-rope to its corner loop on the screen; hand the guys from the pulleys and those from the sides of the screen to the assistants to hold and control; add to each top section one after another of the lower sections till they are raised to their full height; draw the screen up to the pulleys by the loose ends of the pulley-ropes, and have them and the guy-ropes tied to their respective fastenings. Spread out the bottom of the poles, which will be held down in place by weight and the tightness of the ropes. A little adjusting and tightening will smooth out the screen and make it drum-tight. The ropes used are about the size of a clothes-line, or smaller. The guy-ropes attached to the loops may remain or be taken off when the screen is taken down. The screen may be folded to a length to wrap about the ten sections of the poles, and the whole kept in a box 6½ feet long and a foot or so square. The number of sections used, and other details, as before said, can be varied to suit circumstances.

LANTERN PROJECTIONS AS AN EDUCATIONAL APPLIANCE.

Small pictures, though invaluable for private use, seem

the mystic temples and pyramids of the river Nile. They may run riot through the beautiful palaces of Versailles, or may see pass before them a panorama of events covering ages of ancient history.

These wonderful sun-pictures, seen as they are, magnified and illuminated by the intense lights used, convey to the mind of the spectator a better idea of the places and scenes depicted than could be had by reading volumes upon volumes of books of travel. In speaking of the statuary shown, the artists themselves say, that the fullest beauty of the original sculpture is stereoscopically reproduced; in fact, the marble seems standing out before you in bold relief.

Projected pictures in the lecture room have peculiar advantages over charts and sketches, which are so much and so deservedly praised by modern educators. They arrest attention, as when there came forth fingers of a man's hand and wrote upon the plaster of the wall in Belshazzar's palace. They are not subject to wear and tear, like unwieldy picture charts let down from rollers or sorted out of mammoth portfolios, but they follow one another without fuss or confusion, "like the baseless fabric of a vision," and then dissolve away and relieve us from all care. They may be enlarged or contracted, or raised or lowered, or faced to right or left, or changed from grave to gay, or varied by a succession of surprises with the greatest facility, though in appearance they are as large and solid

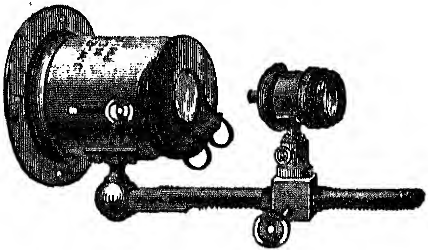
modern favorite, the blackboard, even with an accomplished draughtsman as lecturer

While these projections may not fully take the place of models and physical instruments, they may be largely used in their stead; and, moreover, they can present enlargements of what in them is small, bring into view hidden parts, show in detail what is complex, and so cover the whole ground of an extensive and expensive assortment of other philosophical apparatus, and very much besides.

The London "Times" says of these sun pictures: "You look, and straightway you stand beside the fabled Nile, watching the crocodile asleep upon its sandy shore, wi h the superb ruins of Philæ in the distance. The scene is changed, and you are in the desert, gazing at the half-buried and mutilated Colossi which stand before the great Pylon of the temple at Luxor. You see the Pyramids, with the wonderful impress of 3,000 years upon their sloping sides and angles, most marvelously rendered. The Avenue of Sphynxes, the Hall of Columns at Karnak, the Memnonium at Thebes are presented to the eye as a spectator on the spot would behold them, with every variety of effect from sunlight and shadow, from the flight of centuries and the destroying hand of man, fully and powerfully rendered.

"It is the education of the eye in the most striking and effective sense which is thus practised, for nothing is omitted in these sun-painted revelations, and the simplest intel-

mounted with Canada balsam, between two discs of glass. They consist of details in the anatomy of a bee, wasp, flea, spider, larvæ of insects found in stagnant water, as



gnats, dragon-flies, parasitic and other insects; parts of insects, sections of woods, teeth, bones, fossil bones, shells, lace, silk, muslin, etc.; and as such objects are smaller than paintings for the lantern, and contain more delicate details, a proportionately higher magnifying power is required, which may be adapted to the front of the Sciopticon.

The ordinary lantern microscope objective, sold at about $10.00, has a high and low-power combination. There is, however, all the need of achromatic objectives for projections that there is for the common microscope; in which case the cost cannot be less. The apparatus shown above, with an inch objective, costs about

decomposition of water may be shown to an entire audience. Aided by a six-cell Smee's, or Grove's, battery, and a small thin tank, the power which palladium possesses of absorbing nine hundred times its volume of hydrogen may also be shown; the snake like contortions of the strip of metal, and the bubbles of gas escaping on the reversing of the current, proving very interesting.

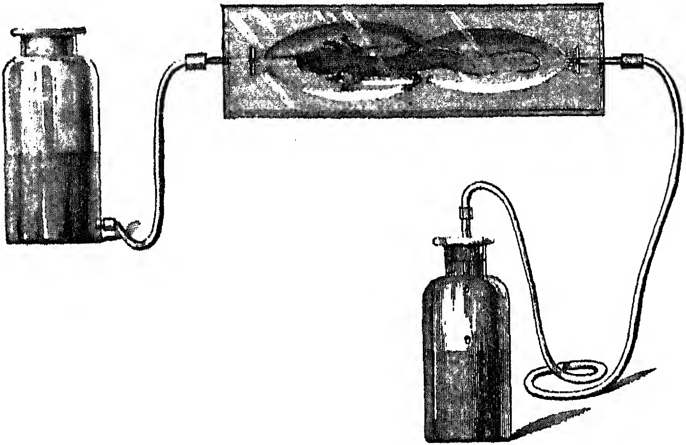
The crystallization of salts may also be shown by placing a drop of a strong solution of Epsom salts, or sulphate of copper (blue vitriol), on a piece of glass of suitable size.

Another effective result is obtained by placing in the glass tank a small horse-shoe magnet, and dropping around it some iron filings, which will be found to arrange themselves, or rather be attracted by the magnet, in a most extraordinary manner.

Exhibitions of microscopic objects by the aid of the magic lantern in the drawing-room sometimes fail to give that complete satisfaction which is desirable, owing to attempts being made to show them on too large a scale in proportion to the light employed. We have given very satisfactory exhibitions on a sheet of Imperial (22 x 30) white card-board, fastened by drawing-pins to a board, and fixed against some books or on a chair. In this way the proboscis of a blow-fly may be enlarged to two feet in length, and this is found to be

instead of being projected directly on an opaque screen, may be thrown down at right angles on a sheet of paper placed on a table, and a drawing very conveniently made.

HOLMAN'S SIPHON SLIDE CAGE allows the passage of a continuous current of water for the purpose of keeping it cool in the focus of light. It is designed



for showing the circulation of the blood in a tadpole's tail, of the sap in plants, &c. Its price, without the

upon the screen, with the gas microscope, has always been a thing much desired by all those who have made use of the magic lantern as a means of demonstration, but the difficulties attending this experiment have been found much more serious than was anticipated beforehand.

This is especially the case to one who has been accustomed to use the solar microscope, in which the advantage offered by the parallelism of the solar rays is of so great value.

On account of the smallness of the object illuminated, as compared with errors of focalizing or concentration in the cone of rays coming from the condenser, all the advantages in the use of a lens in a magic lantern, as compared with its use in a camera, or the like, disappear, and the lens of the microscopic attachment is left to its own resources (on the subject here referred to, see *Journal of Franklin Institute*, vol. 62, page 208; *Scientific American*, 1863, vol. 29, page 163), without any of that aid from the condensers which they afford so effectively to the objective of the magic lantern in its best form of construction.

Among the errors which thus become conspicuous, the most manifest and vitally important is the want of "flatness of field."

By reason of this, while the centre of the image is well-defined, the edges are indistinct and unsatisfactory. To obtain lenses free from this defect has been the continuous

presently, but we will here only remark that, as the result of a large experience, we have become convinced that one must be contented with a moderate amount of success in this direction, and not expect what is, at present, at all events, impossible.

The second great defect that we encounter in the use of the microscopic lens for projection, is the irregularity of distribution of light upon the screen.

By reason of this we may have a field of light with a small bright area at the centre, rapidly fading off into darkness, with no well-defined margin.

The causes of this are, among others, the confusion or want of accurate concentration of the cone of rays from the condensers, and the smallness of the objective, causing it to cut off oblique or marginal rays more or less, according to their obliquity. To remedy this difficulty we can work in two directions.

In the first place, we may improve the spherical correction of the condensers, or the concentrated character of the source of light. The first of these improvements has already been carried to its practical limit in the best sort of condensers, and the second involves the use of the electric light or of sunlight.

In the second place, any increase in the diameter of the microscopic lenses, without a corresponding increase in their actual length, insures a great gain as regards the equal illumination of the field.

true, but when such lenses are thus used and of sufficient size to secure this result, their errors of spherical aberration and want of flatness become unendurable.

We are then fenced in on either side by the necessity of a large and short lens to secure an equal illumination, and the difficulty in securing flatness or correction under these conditions.

The most successful compromise which we have yet found in this connection is the gas microscope objective, of 1½-inch focus, made by Mr. J. Zentmayer, the well known manufacturer of microscopic stands and lenses.

With one of these, a well defined object, such as a lady-bug, mosquito, or the like, may be thrown on the screen with a clear image, pretty well defined up to the margin, and a field of light so brilliant and regular that it is hardly distinguishable from that of an ordinary magic lantern projecting a colored glass slide of the same object. Of course, with such a power, very minute objects must be rejected, but by a judicious selection a large series of interesting ones can be secured, such as the lady bug or mosquito already mentioned, the ant lion, field spider, and various water insects or larvæ of mosquitoes, and the different sorts of flies; also wood sections, and even objects so small as the eye of a dragon fly, but, above all, with this power may be most successfully shown what are by far the most popular illustrations with the gas microscope, such living specimens as the various larvæ above mentioned, and such other

This, when in use, is closed by a thin glass cover, which is kept in place by adhesion and atmospheric pressure, the cavity beneath it being filled with water containing the insect or other object.

If it is desired to use high powers, we must be contented with a limited selection of objects, choosing such as are strongly defined and well colored. Diatoms, blood-disks, or other objects which are delicately tinted or colorless are quite unfit for such use. A strongly colored eye of a fly, sting of a wasp, or other part of an insect, such as a claw of a spider, answer well.

In this case I have obtained the best results with Zentmayer's $\frac{4}{10}$ objective, using an extra condenser, consisting of a plano-convex lens of about three inches focus, and an inch and a half in diameter, placed about an inch back of the object.

This greatly increases the illumination of the field.

In using the gas microscope, much depends upon the efficiency and convenience of the support for lenses and the stage, or what is known commonly as the "gas microscope attachment."

The microscope attachment for the Sciopticon is represented by the following wood cut.

The microscope body, to which the objective is attached by a sliding tube, is fitted to the grooved arm, and moved by rack and pinion for accurate focus-

The object carrier is made of strong plate glass, pressed down by an adjustable spring, admitting of a delicate movement of over one inch perpendicular and two inches lateral. Two sliding bars, fitted to the edges of the glass plate, hold the objects, which may be of different sizes, to the stage. In principle it is what is known by microscopists as Zentmayer's glass stage. If a secondary condenser is required, it is fitted to the attaching tube back of the stage.

THE MEGASCOPE.

Although the light reflected from the illuminated opaque object in the opaque lantern is dim, as compared with the direct rays through a magic lantern slide, and, notwithstanding the dispersion of a large portion of even this reflected light from the line of the Megascope objective, yet the image of small objects may be thrown upon the screen on a large scale with sufficient distinctness, not only to be interesting, but to be practically useful for purposes of illustration.

Bright objects presented at the proper angle, such as a watch with its movements, flowers, minerals, beetles, butterflies, etc., show quite brilliantly, while the images of duller objects, or of plain pictures, are hardly suggestive of the title of Wonder Camera, commonly applied to this arrangement.

Only a portion of most objects can be in focus at once, for the lack of a flat surface. To bring out a distinct image

door D, hinged at the shorter side, closes at an angle to reflect the light in the direction of the focusing lens o, which in this case is the Sciopticon objective screwed into a duplicate flange. The aperture in the middle of this door, or Megascope stage, allows the object or *carte de visite* to be attached to the outside by springs, and does not prevent the object or picture from being attached to the inner surface, which is also provided with springs.

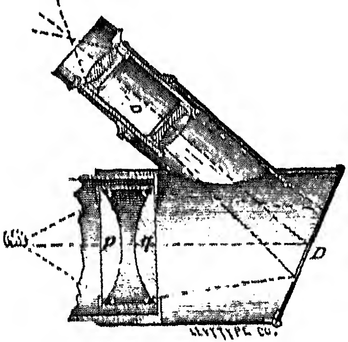


Fig. 55.

Flame illumination has the peculiar advantage, in the Megascope, of covering some two and a half inches at this outer conjugate focus of the condenser, so that a portion of the margin lost in the lantern is here available. The lime-light makes at the focus a bright hot spot, sometimes necessitating the drawing the Megascope forward, which does not change the angles in relation to the lenses.

The Megascope has greater advantages as an attachment to the Sciopticon than as a separate apparatus, for the illumination is better; it telescopes over the lantern body, which is not in the way of the backward direction of its objective; it is simple and inexpensive, and what it can do for

sound vibrations as reflected from a soap film stretched over an aperture, round or rectilinear, an inch or two in diameter. It grew into being from observing the vibrations of telephone plates. Our form of it took shape from witnessing the very successful exhibitions by Prof. Holman, of the Franklin Institute.

A piece of glycerine soap, about the size of a marble, sliced and dissolved in water, 110° Fahr., will make a bubble that will last several minutes. A still more persistent bubble is produced by a druggist's preparation which we supply.

The illustrated description of the Megascope, on page 217, explains the Phoneidoscope as far as it goes. Attached to the hinged door D, is the resonator, with metal tubes, either of which can be connected with a mouth-piece by a rubber tubing. One of the metal plates, of which there are several, with the inch aperture, slides down in grooves till the aperture is where the object is placed when used as a megascope, and till the bottom reaches to the bottom of a narrow cup holding the soapy fluid. A metal strip also reaches down to the bottom of the cup in the same grooves, which, when drawn up, spreads the soapy film over the aperture, and then remains up till again needed. When the lantern is lighted and in position, the edge of the aperture and the marking on it can be focused on the screen. Now, by taking the mouth piece and singing into

effects produced by the instrument will welcome its adaptation to the magic lantern, which, notwithstanding the attendant optical difficulties, has at length been accomplished.

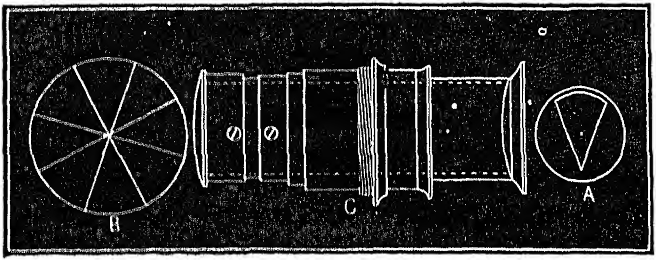


Fig. 56.

The instrument is shown in section at Fig. 56; *A* being a sectional view, showing the disposition of the mirrors; *B*, an outline of the eight-celled image; *C*, a side view of the brass mount, containing the reflectors and lenses, with sliding adjustment for focusing, and projecting the image upon the screen.

It is attached to the lantern by unscrewing the front and screwing the kaleidoscope into its place, turning it round in its sliding tube until the reflectors are upright, like the letter V. A rack slide, containing some fragments of colored glass, bugles, beads, and other transparent objects, is also shown; this is introduced into the usual slide-holder of the lantern, and the focus adjusted

can best be done by sliding a narrow board under the blow-pipe. The maximum of illuminating power is obtained in the usual way, by pushing the light backwards and forwards, and the correct focus is obtained by means of the *front* sliding tube. Any dark portions of the image may be removed by turning the kaleidoscope round a very little to the right or left.

The instrument, before using, should be warmed, to prevent what is popularly known as the "steaming of the glass."

Rackwork frames, containing pieces of colored glass, are supplied by the opticians; but exceedingly beautiful effects are obtainable with the chromatrope, a piece of perforated zinc, the bow and the wards of a key, grasses, feathers, a bunch of oats, etc., etc.

THE OXYHYDROGEN POLARISCOPE.

Fig. 57 shows the Oxyhydrogen Polariscope, which consists of two tubes inclined to each other at an angle of 56° 45′, and truncated at their points of junction; the oval space thus formed being closed by some ten or twelve pieces of thin crown glass, the lowest of which is blackened to absorb the polarized ray. This apparatus replaces the object-glass of the lantern, which should have condensers not less than 3½ inches diameter. When attached, it will be seen that the light emanating

not exceed three feet in diameter.

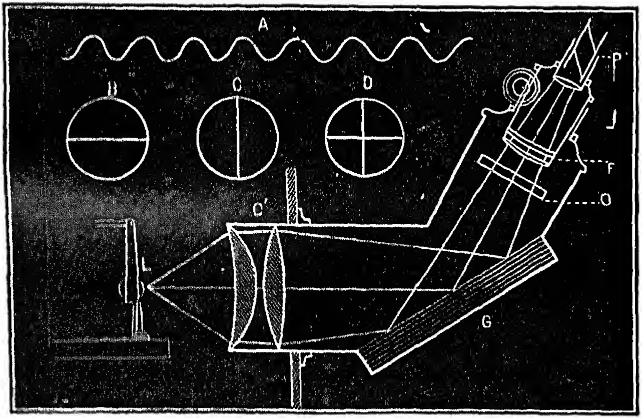


Fig. 57.

The phenomena connected with the polarization of light are attended by a most gorgeous display of colors, and are, in consequence, among the most attractive in the whole range of physical optics; an apparatus, therefore, which facilitates their exhibition to an audience becomes a most valuable adjunct to the magic lantern.

The subject itself is, however, of too recondite a nature to admit of adequate treatment in the present manual; the reader is therefore referred to Pereira's lectures on

any matter the particles of which are in a state
tension. Specimens may be seen, and lists of the vario
designs are obtainable, from opticians supplying t
apparatus.

In Fig. 57, the polarizer consists of a bundle of gla
plates, *G*, with the Nicol's prism, *P*, to analyze t
polarized, reflected rays.

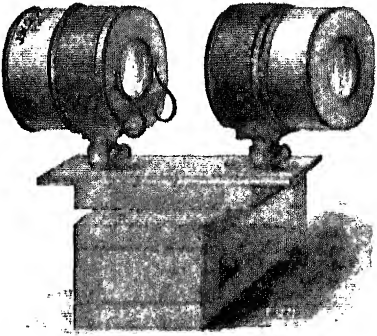


Fig. 58.

The polariscope here represented (Fig. 58) consists
a Foucault prism, of 36 millimetres in diameter,
polarizer, and a Nicol's prism, of 20 millimetres
diameter, as analyzer.

bition, the expedient, next to perfecting the instrument itself, is to bring into use larger and clearer views.

A magic-lantern colored and sealed picture of the standard size is 3 inches in diameter, mounted in a frame 7 inches long by 4 inches wide. The new picture, which is our standard size, is 3½ inches in the clear, in a frame 7 inches by 4¼ inches.

The new picture having a third more surface, the illuminated disk shows larger in proportion, and to very much better advantage. No one, seeing an exhibition of the new slides, would willingly select from the old.

CRYSTAL SLIDES.

Our crystal slides, having a square opening with rounded corners, show a larger area than the 3-inch round pictures, and are as finely painted. Crystal slides fit the slide-carrier, and are less bulky than such as are bound in wood; they do not cut off the heads and feet of side figures like a circular margin, and they hold their color better than sealed slides. By taking more time and pains, a still better quality is produced.

COLOR.

The better class of colored slides will doubtless, to a large extent, continue to be a necessity, notwithstanding plain photographs on glass, which are now made so fine, so abundant, and so cheap, constitute our main reliance. The work of the skillful painter is too costly to be largely

ers, costumes and equipages, shingled roofs and chimney tops, pasture grounds and fields of grain are more readily differentiated by natural coloring than to have it wholly done by different degrees of shading. Besides, shading, so far as it goes, shuts off light, while color distinguishes the various elements from one another, and illuminates them as well. A finely-colored view, not too densely shaded with black, is brighter, more distinct, and more pleasing.

OUR BUSINESS.

Slide-making is our business. Like others, we deal in domestic and foreign slides. Our special peculiarity is, that we are ourselves extensively engaged in manufacturing slides, both plain and colored, in our own establishment. We began years ago, with the best American and English methods and assistance, and have been able to much improve upon those methods since. We employ skillful artists in designing, arranging, photographing, painting and mounting slides, in great variety. This imposes on us the labor of preparing specialty slides for parties far and near, from such designs of their specialties as can be procured. The slides thus made are not all equally good, but we are able to produce good results as compared with the designs. Our own assortment of negatives is very extensive, and is constantly increasing.

Those who take an interest in the matters considered in